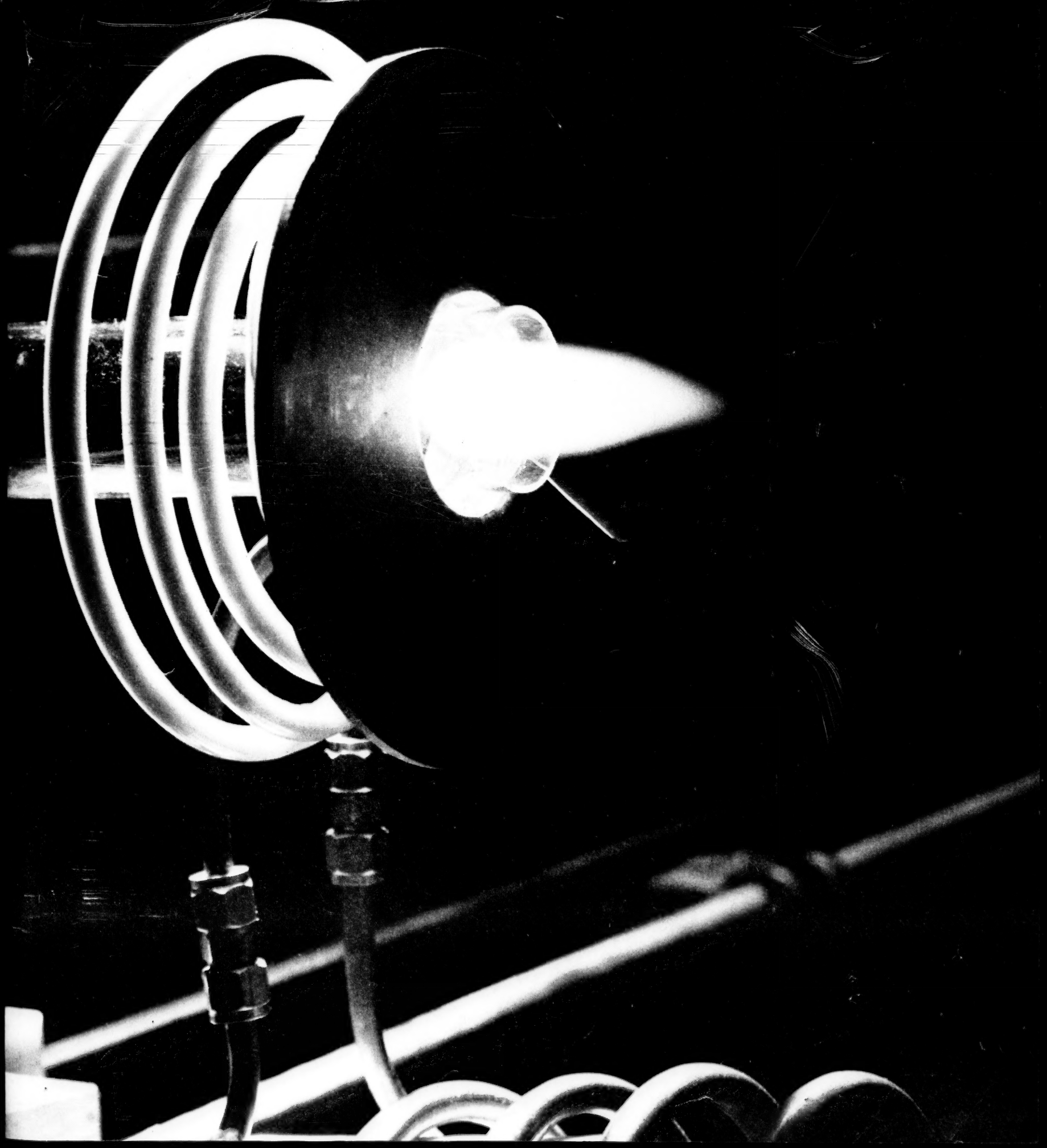
Aviation Week
and Space Technology
A McGraw-Hill Publication

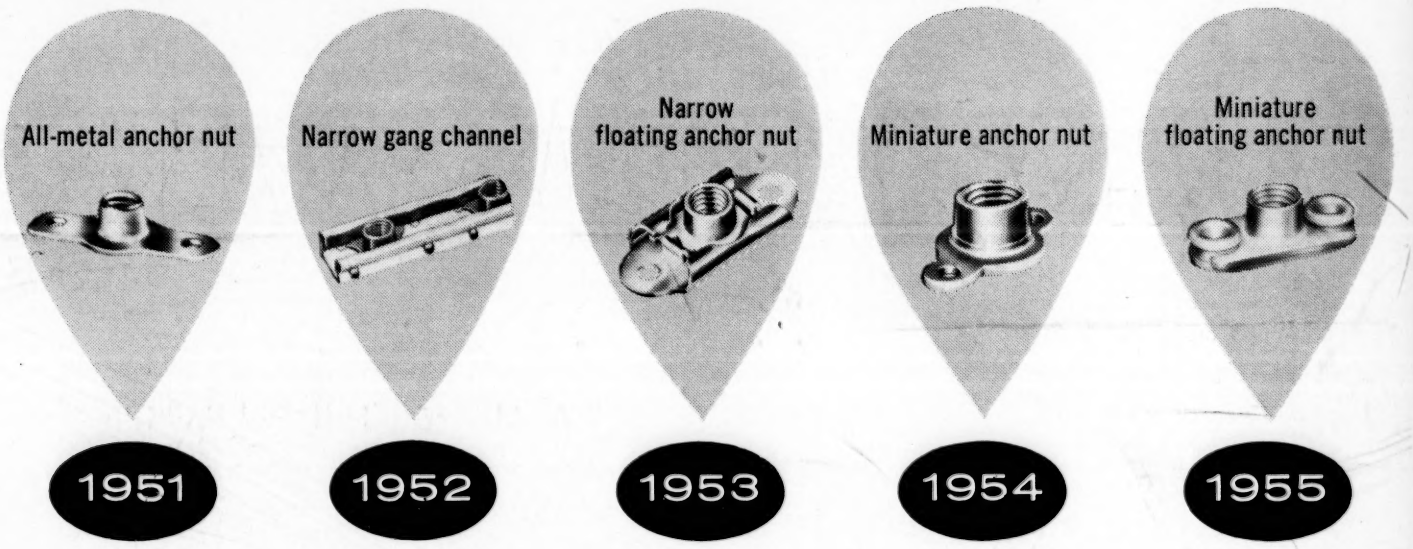
March 27, 1961

Project Phoenix Aims at Low-Cost 50-Ton Payloads

Avco Electrodeless Arc Je

UNIVERSITY OF MICHIGAN





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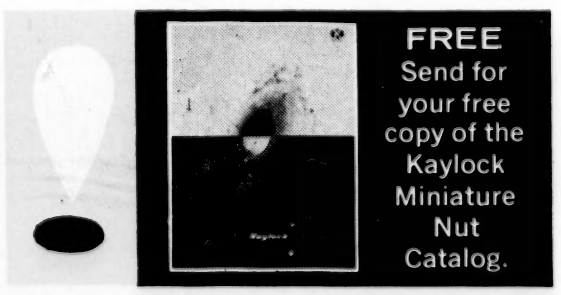
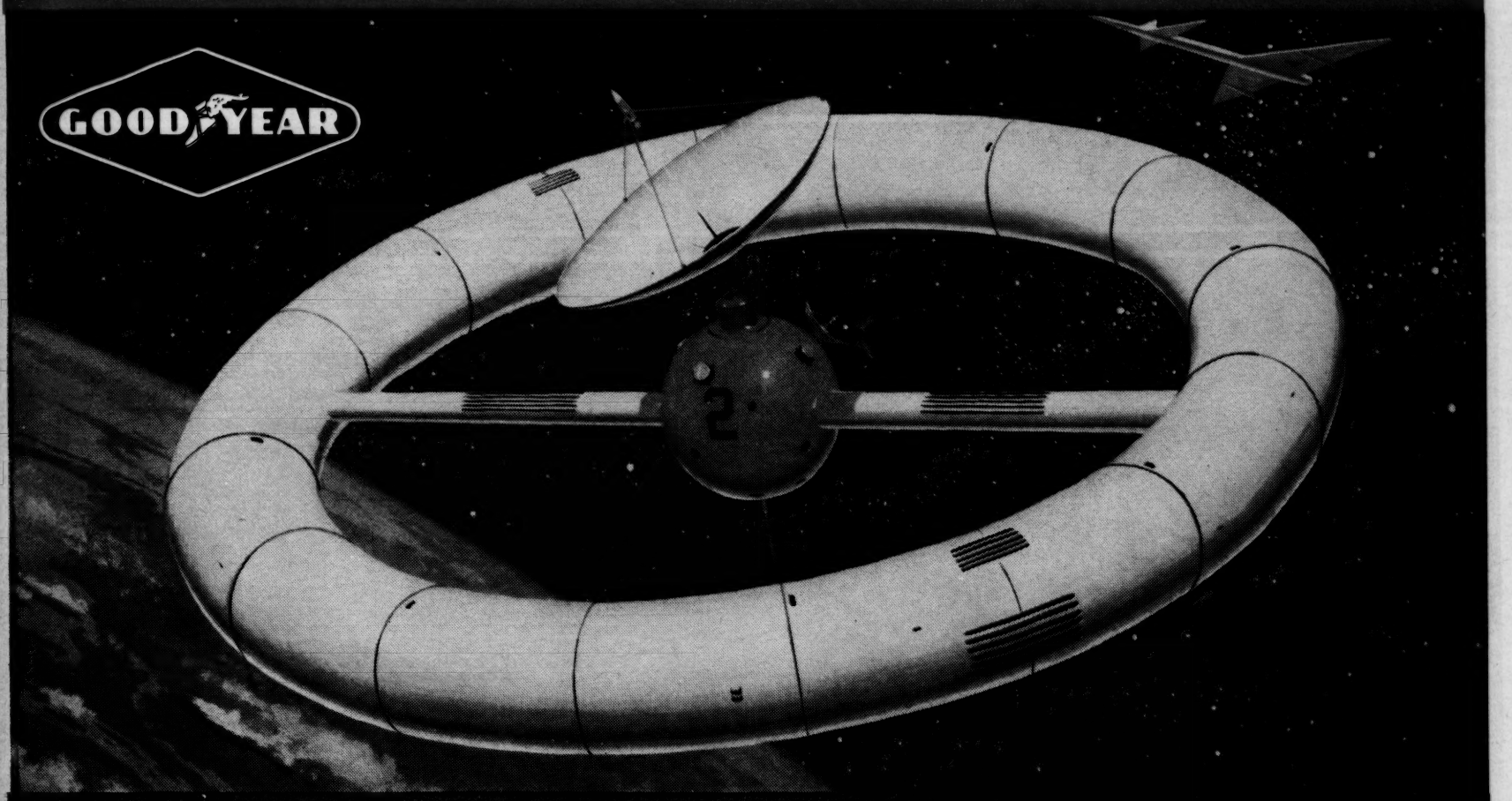
Kaynar Mfg. Co. Inc., the world's largest manufacturer of lightweight, all-metal self-locking nuts, leads the industry in solving aircraft, powerplant and missile fastening problems. Our elliptical locking feature is adaptable to an unlimited variety of configurations and materials, answering today's many sophisticated design requirements. Kaylock nuts are available in carbon steel – CRES steels for use to 1200°F – or exotic metals for temperature above 1200°F.



Kaylock® *first in lightweight locknuts* Trade Mark

KAYNAR MFG. CO., INC., KAYLOCK DIVISION
Box 2001, Terminal Annex, Los Angeles 54, Calif. Branch offices, warehouses & representatives in Wichita, Kan.; New York, N.Y.; Atlanta, Ga.; Renton, Wash.; Montreal; Paris; London; The Hague

EXPANDABLE STRUCTURES: Another prime capability of Goodyear Aircraft



Way station to the stars, GAC-designed space structure, with solar collector and communications antenna, is completely expandable.

HOUSING PROJECTS 500 MILES UP!

Expandable fabric structures for space missions inherently provide the advantages of minimum structural density, maximum volume/weight ratio, unmatched packageability on boost – making possible full-size erection and deployment in space with minimum launch penalty.

Expandable structures are being applied to a wide range of space applications – from manned space stations and ultra-lightweight solar concentrators to re-entry vehicles where aerospace engineers are applying new high-temperature, high-strength fabrics.

With 50 years of practical experience in developing specialized fabrics and fabric structures, Goodyear Aircraft is in a unique position to put this new technology to work at once. Whether the need is for a complete space system or major subsystems, GAC stands ready to utilize its unequaled facilities – research, engineering and production. If this new approach will help your project get off the ground, write Goodyear Aircraft Corporation, Dept. 914AC, Akron 15, Ohio.

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GOODYEAR AIRCRAFT CORPORATION

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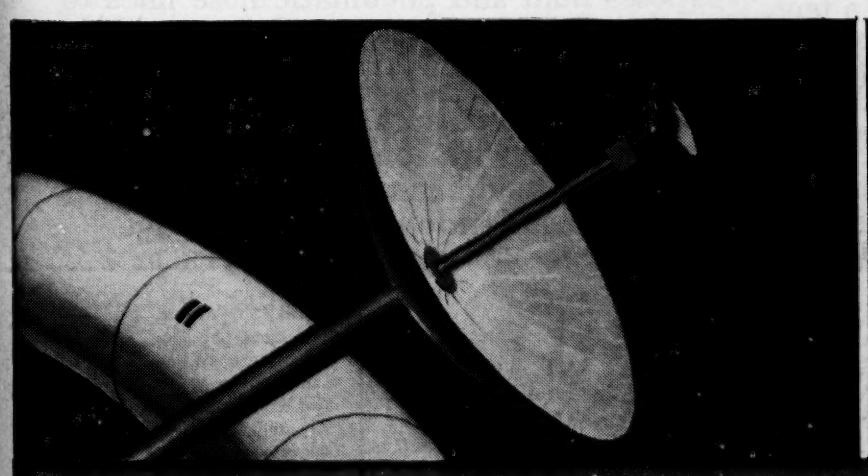
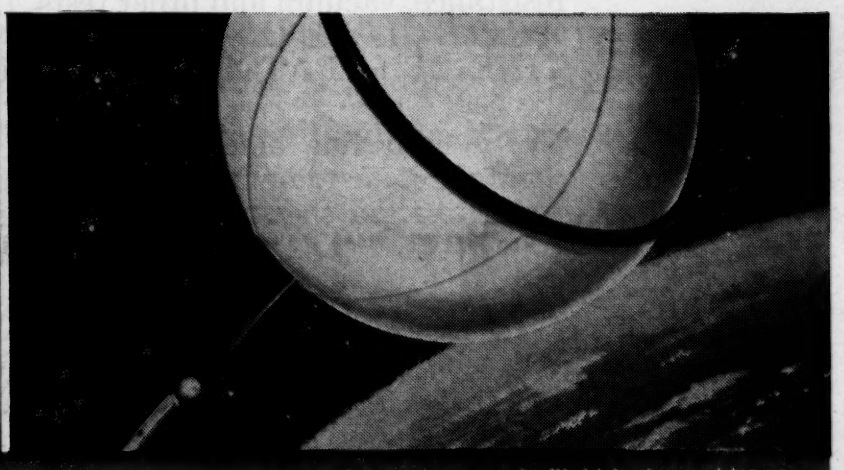


Solar concentrator with new "trumpet" condenser expands to 44½-ft. diameter. Design has been thoroughly tested for space environment.



Ballute recovery system, tested and proven in flight test, provides variable controlled drag for re-entry vehicle.

WHITE GLOVE INSPECTION

The Stratoflex Testing Laboratory continually evaluates products on a development and surveillance basis, the capability of hose assemblies to withstand prolonged conditions of heat, cold, thermal shock, hydraulic impulse, vibration, flexing, pressure, elongation and contraction, fluid resistance, vacuum and other tests. In fact, WHITE GLOVE INSPECTION IS ROUTINE OF STRATOFLEX PRODUCTS.

Every fluid line assembly ordered by a Stratoflex customer has been manufactured to rigid specifications and has been carefully inspected and tested to assure the highest standard of quality and performance.

Engineers in the Stratoflex Testing Laboratory utilize the most modern and precise equipment available. This equipment exposes fluid and pneumatic hose lines to conditions beyond those encountered in specific applications.

For your requirements for hose and fittings that perform with complete reliability, regardless of fluid line requirements, contact your nearest Stratoflex Representative.

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Toronto, Tulsa

AVIATION CALENDAR

Apr. 4-5—Aviation Technician School Administrators Conference, Purdue University, Lafayette, Ind.

Apr. 4-6—International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Apr. 4-6—Lifting Re-entry Vehicles: Structures, Materials & Design, American Rocket Society, Palm Springs, Calif.

Apr. 4-7—National Aeronautic Meeting, Society of Automotive Engineers, Commodore Hotel, New York, N. Y.

Apr. 5-7—Annual Technical Meeting and Equipment Exposition, Institute of Environmental Sciences, Park Sheraton Hotel, Washington, D. C.

Apr. 10-11—Spring Meeting, Western States Section/The Combustion Institute, Aeronutronic Division of Ford Motor Co., Newport Beach, Calif.

Apr. 10-14—International Symposium on Aviation Research and Development, Federal Aviation Agency, Atlantic City.

Apr. 11-13—Conference on the Ultrapurification of Semiconductor Materials, Air Force Cambridge Research Laboratories, Boston, Mass.

Apr. 12-13—15th Annual Spring Technical Conference, Institute of Radio Engineers/American Rocket Society, Hotel Alms, Cincinnati, Ohio.

Apr. 13-14—Annual Meeting, National Aeronautical Services Assn., Hotel Washington, Washington, D. C.

Apr. 13-14—Institute of the Aerospace Sciences/Army Aviation Meeting (classified), Washington, D. C.

Apr. 17-28—14th Technical Conference,

(*Continued on page 6*)

AVIATION WEEK and Space Technology

March 27, 1961
Vol. 74, No. 13

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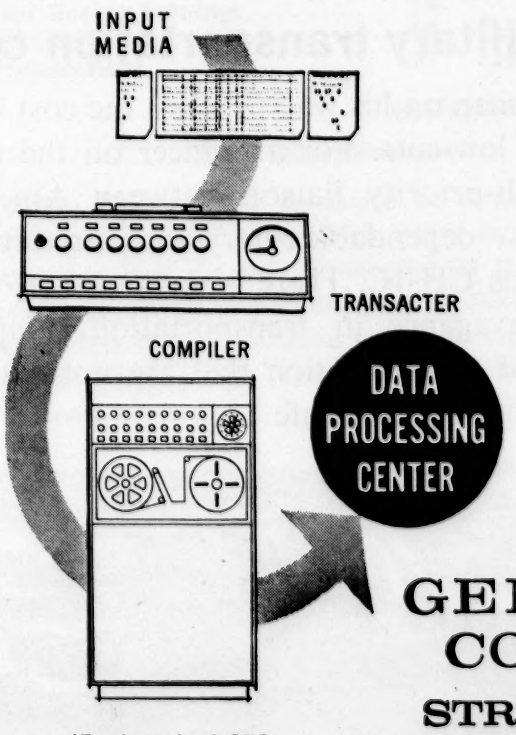
The TRANSACTER* System — the fastest proven method of accurate instantaneous data collection and transmission — provides management with complete data on production status and order location, inventory control, labor costing, tool crib and stores control, receipt and shipment, on-line communication. These are just a few of the many potential assignments for the TRANSACTER System.

Until Stromberg developed the new TRANSACTER System, no accurate, instantaneous method of source data collection existed. Industrial data collection and transmission was a relatively primitive operation — dependent on manual recording and delivery — subject to human fallibility every step of the way. Such methods were incompatible with the accuracy and efficiency of EDP and computer speeds.

The TRANSACTER System eliminates the paper work between widely scattered data sources and a central processing office. Management reports that have taken days — sometimes weeks— can now be produced in minutes! With the TRANSACTER System dramatic new opportunities for profit improvement become evident.

Write for informative booklet.



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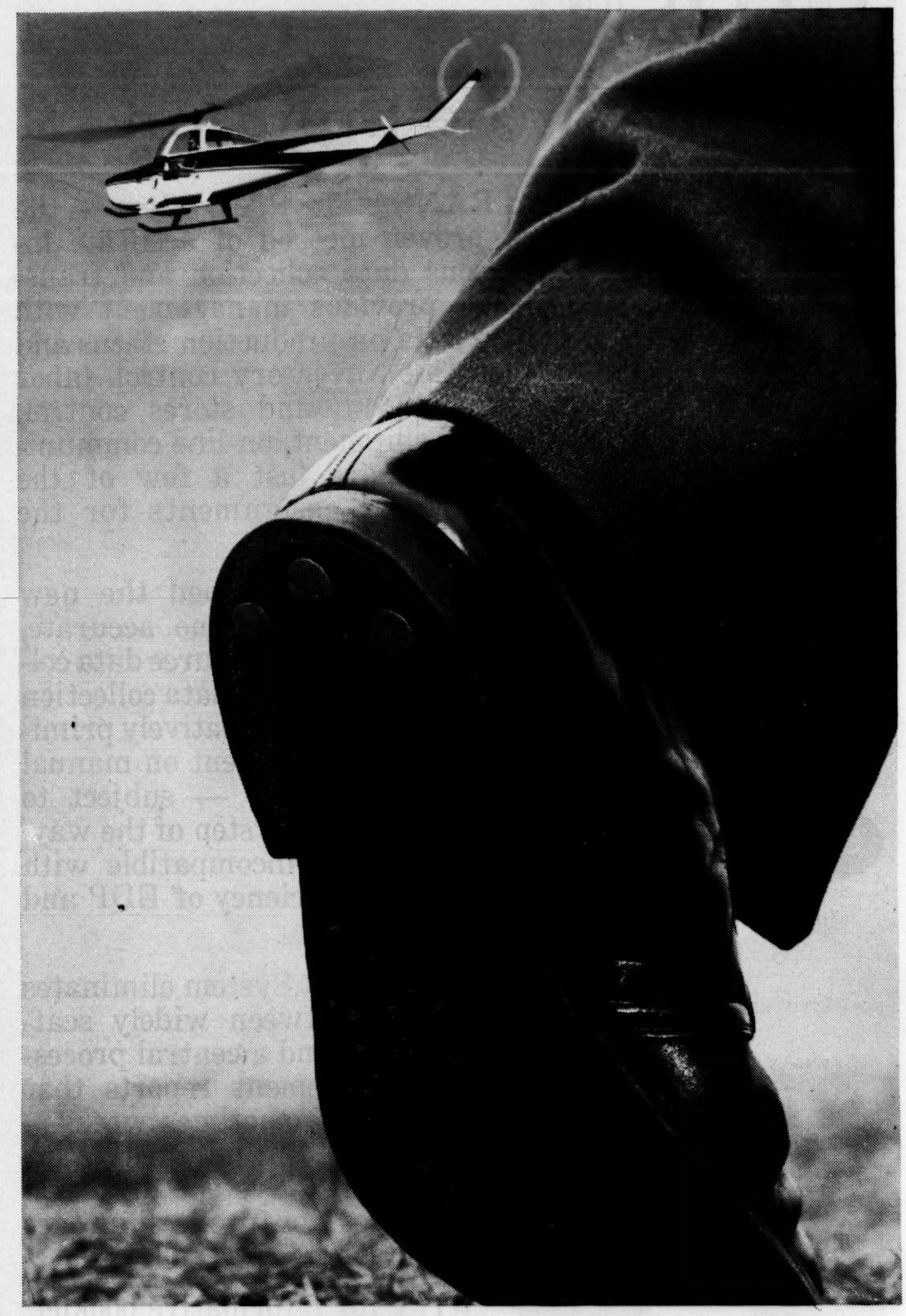
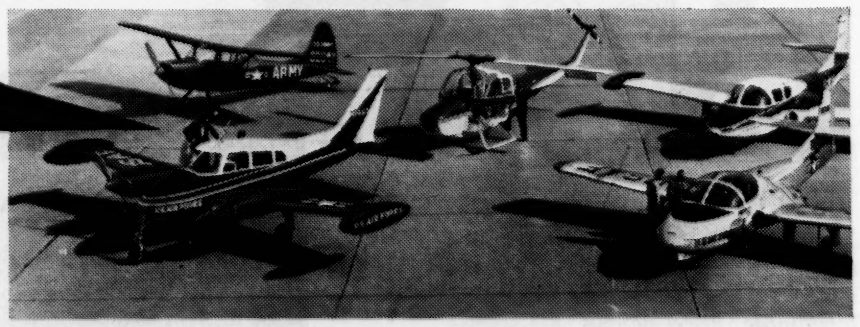


How much should military transportation cost?

It depends. For a soldier or airman on his way to class, the cost would be that of a well-kept pair of low-cuts. For an officer on the move, perhaps a staff car. For high-priority liaison between America's multimillion-dollar weapon sites—dependable rotary-wing aircraft, such as the new, in-production Cessna CH-1C. There is no room in today's streamlined military for extravagance in transportation. Nor can there be patience with forms of transportation that are not equal to a nation's investment in men, money, and safe tomorrows.

CESSNA
Military Division
WICHITA, KANSAS



World's most experienced makers of utility military aircraft

AVIATION CALENDAR

(*Continued from page 5*)

International Air Transport Assn., Queen Elizabeth Hotel, Montreal, Canada.

Apr. 18-20—Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute, Mark Hopkins Hotel, San Francisco, Calif.

Apr. 20—Eastern Regional Meeting, Institute of Navigation, Shoreham Hotel, Washington, D. C.

Apr. 20-22—General Meeting, American Meteorological Society with the American Geophysical Union, Washington, D. C.

Apr. 22-25—Annual Meeting and Conference, American Assn. of Airport Executives, Broadmoor Hotel, Colorado Springs.

Apr. 24-27—32nd Meeting, Aerospace Medical Assn., Palmer House, Chicago.

Apr. 26-27—High Temperature Materials Conference, American Institute of Mining, Metallurgical and Petroleum Engineers, Pick-Carter Hotel, Cleveland, Ohio.

Apr. 26-28—Liquid Rockets, Propellants and Combustion Conference, American Rocket Society, Palm Beach Biltmore, Palm Beach, Fla.

Apr. 26-28—Seventh Region Technical Conference, Institute of Radio Engineers, Hotel Westward Ho, Phoenix, Ariz.

Apr. 27-29—13th Annual Air Meet, National Intercollegiate Flying Assn., Texas A. and M. College, College Station, Tex.

Apr. 30-May 4—Seventh National Aerospace Instrumentation Symposium, Instrument Society of America, Adolphus Hotel, Houston, Tex.

May 2-4—Electronic Components Conference, Institute of Radio Engineers, Jack Tarr Hotel, San Francisco, Calif.

May 3-5—17th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 3-5—Nuclear Applications in Space Conference, American Rocket Society/ Oak Ridge National Laboratory, Gatlinburg, Tenn.

May 8-10—National Aerospace Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio.

May 8-12—Annual Meeting, Airport Operators Council, Carillon Hotel, Miami Beach, Fla. (AOC-American Society of Civil Engineers' Joint Seminar, "Increased Capacity of Airport Systems," May 11-12.)

May 9-11—Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles, Calif.

May 15-17—National Symposium on Microwave Theory and Techniques, IRE, Sheraton Park Hotel, Washington, D. C.

May 15-18—20th Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Hotel, Akron, Ohio.

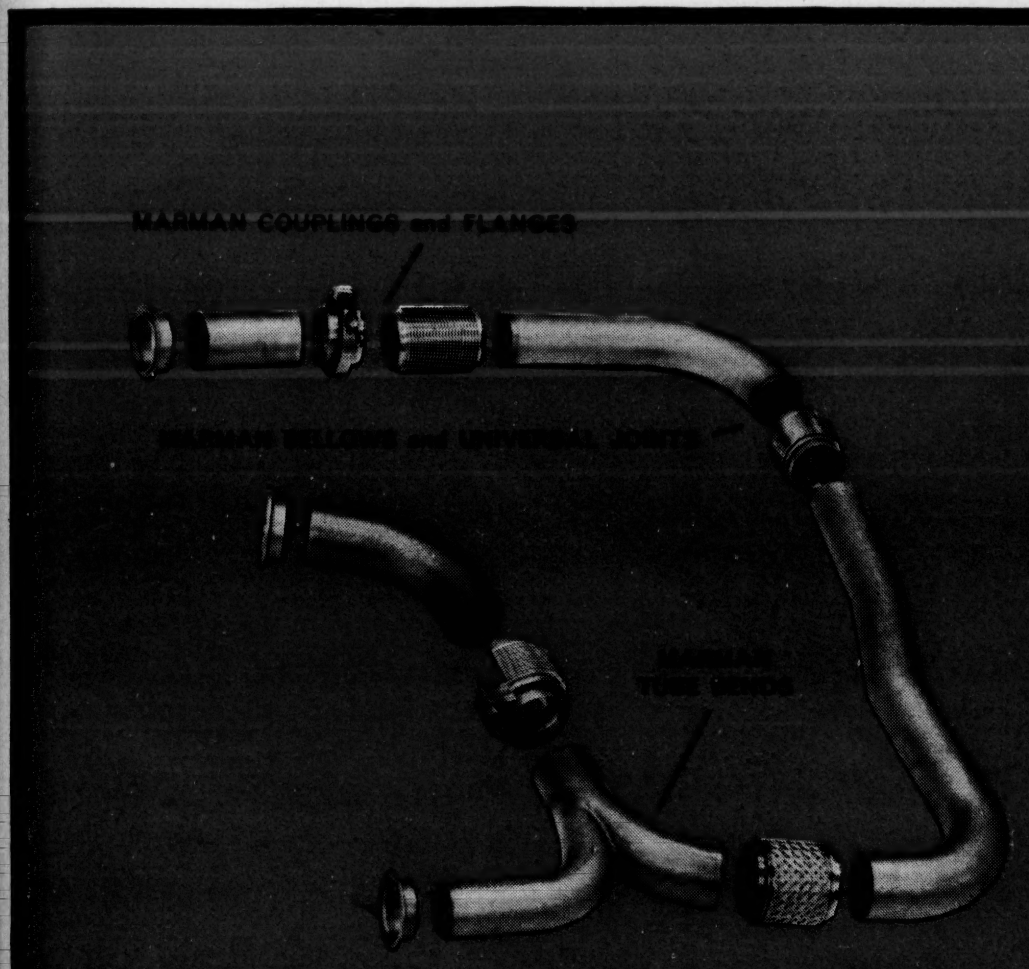
May 22-24—National Telemetering Conference, Sheraton-Towers Hotel, Chicago, Ill.

May 22-24—Fifth National Symposium on Global Communications, Institute of Radio Engineers, Hotel Sherman, Chicago.

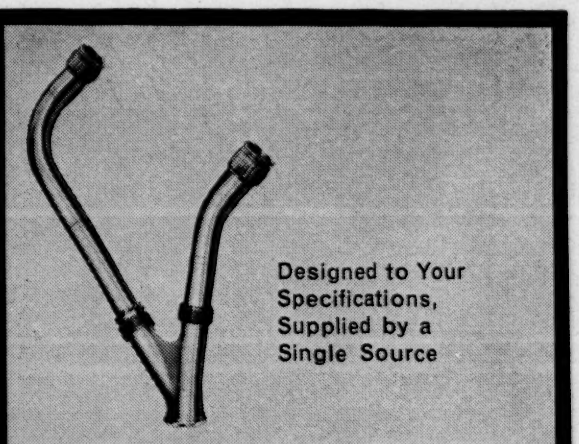
May 26-June 4—24th French International Air Show, Le Bourget, Paris, France.

July 25-Aug. 10—International Trade Fair and Aviation Exhibition, McCormick Place Exposition Center, Chicago, Ill.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.



SEPARATE COMPONENTS



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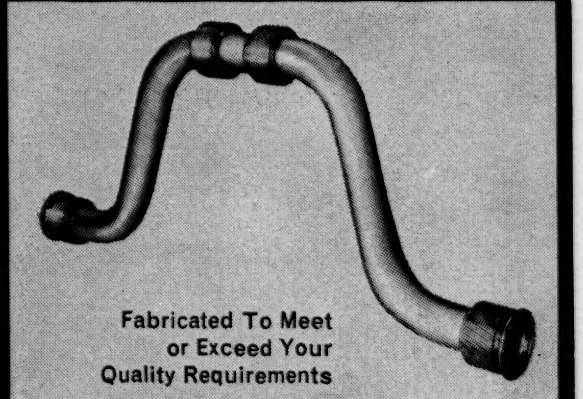

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Whatever your aviation/missile fluid ducting needs, let Marman fill them. Choose between separate components for customer assembly or complete assemblies for low, medium or high performance systems.

Marman can supply separate components in minimum time and at low cost. Marman can also custom produce and assemble any combination of components in a wide range of sizes and types to meet or exceed your design specifications, saving you time and money in the process.

Marman's extensive experience with fluid ducting systems for the aviation/missile fields assures designers and engineers quality products manufactured with meticulous craftsmanship, supplied by a single experienced source. This extensive experience often permits Marman to offer problem-solving suggestions for maximum performance from fluid ducting systems. For full information, write Marman Division today.

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for vital answers in the critical problem of safe air traffic control

GILFILLAN 3-DIMENSION RADAR

Gilfillan has developed a new family of unique pencil-beam scanning radars providing continuous bearing, range and altitude data on aircraft in a volume of airspace extending out to hundreds of miles.

Gilfillan 3-Dimension radars, using new techniques, provide long range, increased angular resolution, higher data rate and increased accuracy. Performance is assured by Gilfillan's unequalled experience, reaching back more than 15 years to development and production of the first volumetric scan GCA. Gilfillan experience and facilities also assure faster production at minimum cost.

The eventual answer in Air Traffic Control – with air traffic expected to double in the next ten years – will be an All-Weather Automated Air Traffic Management System in which Gilfillan 3-Dimension radars will play an important role.

Gilfillan 3-Dimension radars can meet immediate and long-term needs.

Gilfillan
Los Angeles

MICRODOT ACQUIRES 4 SPACE AGE COMPANIES

SOUTH PASADENA — Microdot, Inc., has recently concluded a planned expansion-through-acquisition program designed to broaden the product line and telemetry capabilities of its Instrumentation Division. Each of the acquired companies has been a highly successful, specialized manufacturer of electronic products. These companies are:

1) MICRO-TEST, INC., manufacturer of strain measurement devices. Through this addition, Microdot now offers the only high-temperature strain gage in the U. S.—a device capable of continuous measurement at 750° F. and dynamic test to 1500° F.

2) LERCO ELECTRONICS, INC., manufacturer of a wide range of electronic hardware, including molded terminals, terminal boards, handles, Mil-spec knobs, and many others. In all, Lerco catalogs over 380 standard part numbers.

3) NACIMCO PRODUCTS CO., manufacturer of temperature measuring devices and systems. Nacimco is the developer of a special method of producing miniaturized transducer sensing elements through the use of a unique deposited platinum film process.

4) SPECTRALAB INSTRUMENT CO., provides Microdot with outstanding capabilities in the field of VHF and UHF cavities and related instrumentation. This was the first company to have an operational UHF telemetry transmitter and continues to accomplish advanced work in the UHF telemetry field.

According to Microdot President R. S. Dickerman, "At Microdot we keenly feel a dual responsibility; first and foremost to make a positive contribution to the defense of our nation, and secondarily to show a satisfactory growth performance for our shareholders. We believe that we have served both purposes through our recent acquisitions. By strengthening our specialized capabilities, we are achieving a high degree of technological advancement, at utmost speed, with maximum economy."

MICRODOT INC.

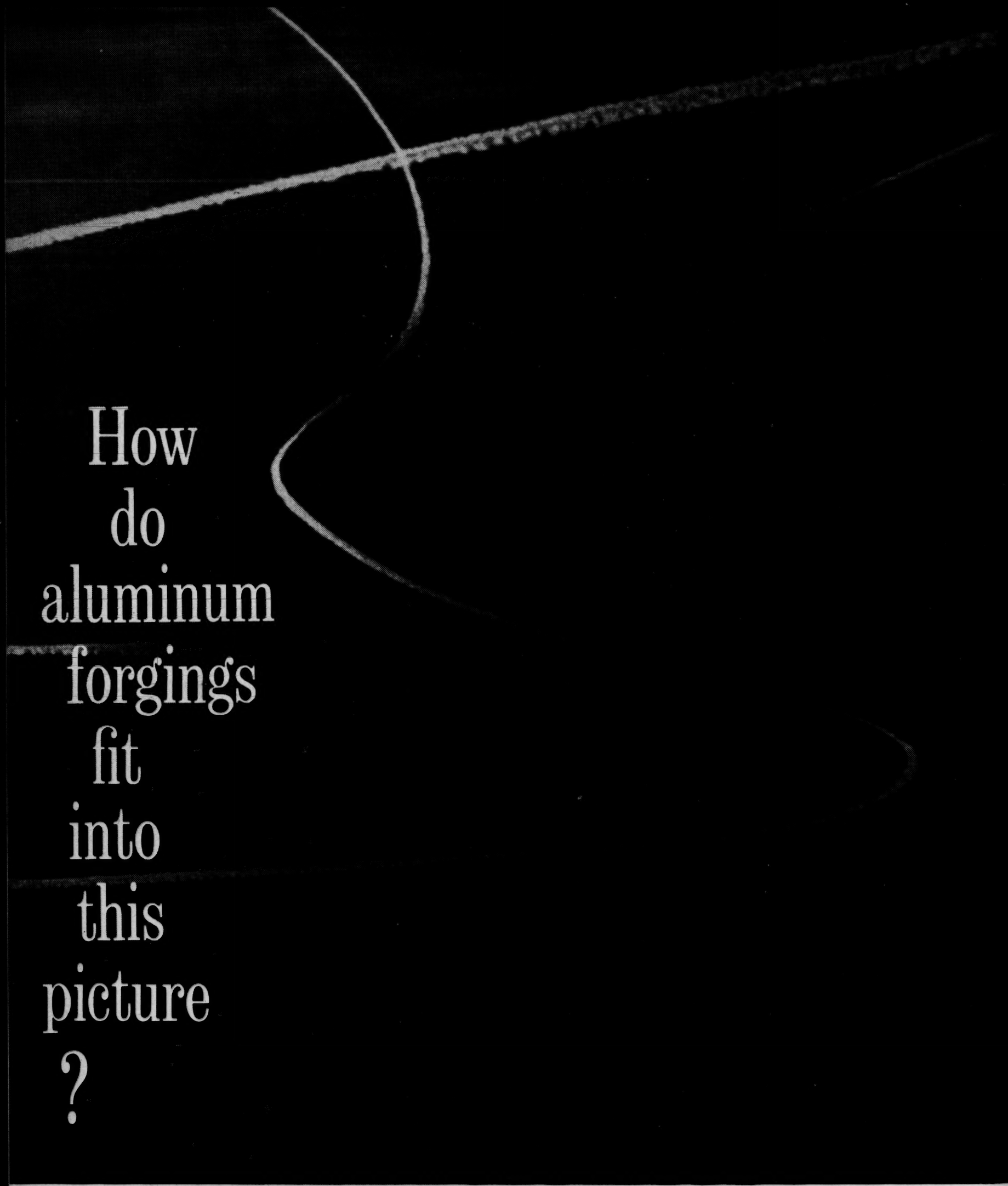
220 Pasadena Ave.
South Pasadena, California
SYcamore 9-9171 MUrray 2-3351

No man in his right mind would start another war

Granted. Everybody knows it.
Only one trouble. Not everyone is always in his right mind.

Remember?

That's why those of us in the defense business should pause from time to time to take stock of what we are really doing . . . keeping fingers off buttons.
Because the real business of the defense business is survival.



How do aluminum forgings fit into this picture ?

VIRTUALLY every United States aircraft, missile and satellite that reaches out into sky and space does so with the help of Kaiser Aluminum forgings . . . helping man fly higher and faster than ever dreamed.

Kaiser Aluminum's Erie forging plant is presently making hundreds of forged parts for today's aircraft, missiles and satellites . . . everything from directional fins to landing gears.

Supplying this market with such high-precision, high-quantity components is a demonstration of Kaiser Aluminum's ability . . . now and in the future . . . to meet the growing needs of the aircraft and missile industry.

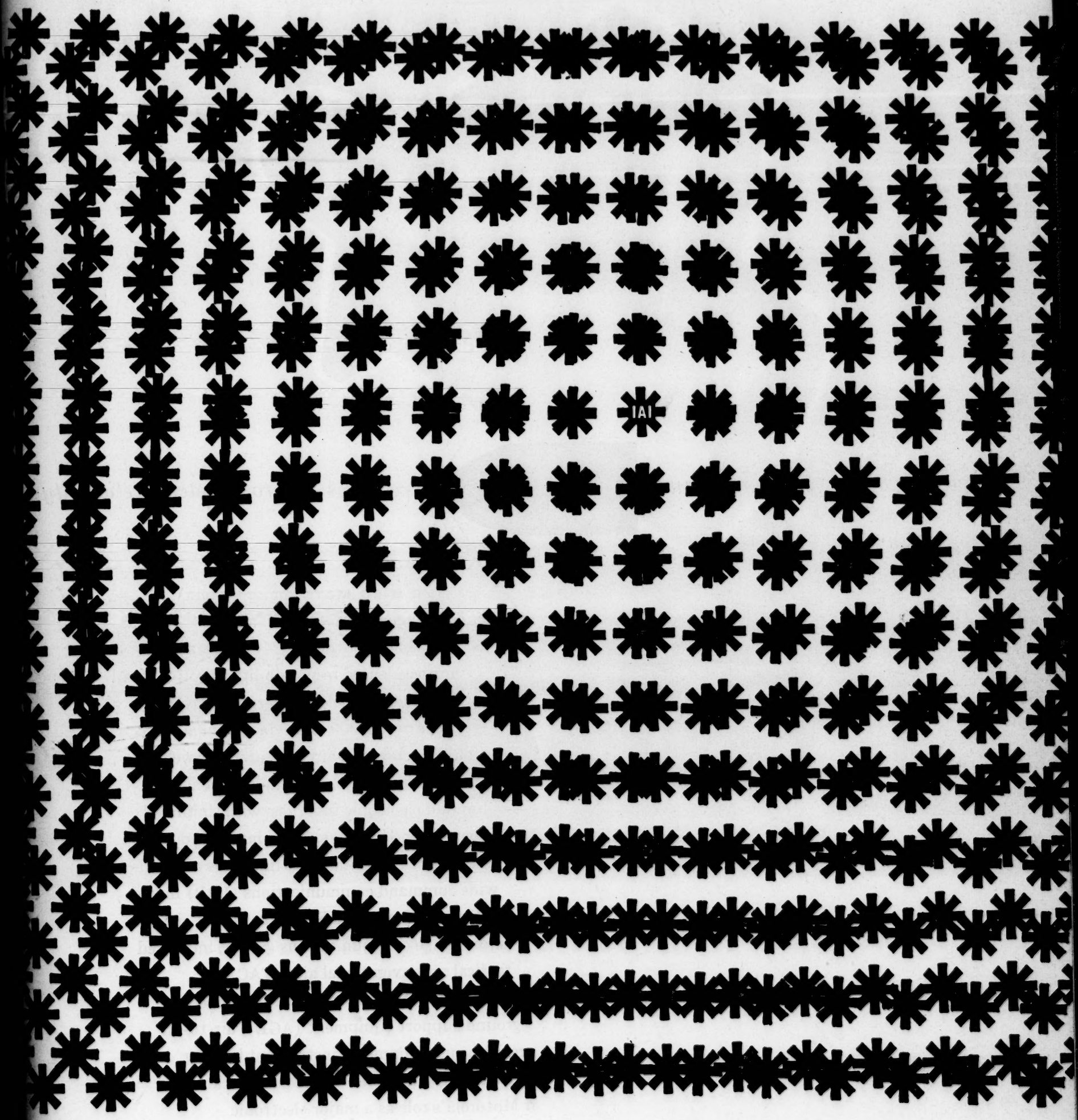
The size, shape, speed and destination of our future sky travelers is unknown. But it's a good bet that if they're off the ground . . . Kaiser Aluminum forgings will help put them there.

When you need forgings, be sure to obtain a bid from Kaiser Aluminum.

See HONG KONG and MAVERICK weekly, ABC-TV Network.

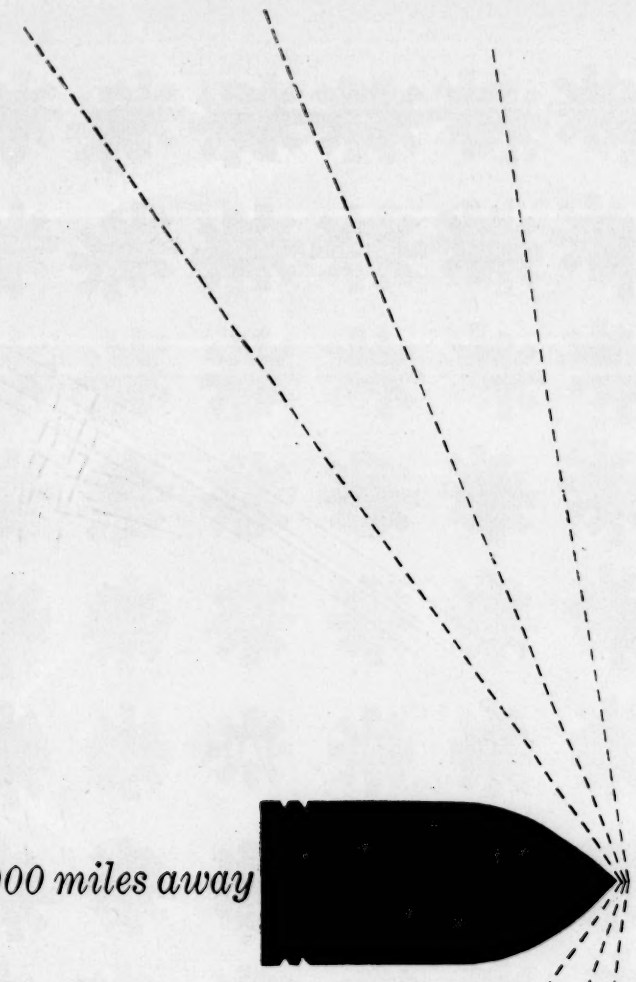
KAISER ALUMINUM

NEW LEADERSHIP IN THE WORLD OF ALUMINUM



Significant and essential—sometimes critical—data must be drawn immediately from the vortex of visual/digital/audio signals presented to the display device of a multisensory military information system. Display techniques used in Houston Fearless Corporation's IAI system for *information acquisition* and *interpretation* present only data relevant to the real-time and anticipatory decisions that a trained observer must make instantly. Military and scientific events may then be monitored and controlled with the assurance that distracting signals will not be presented to compromise effectiveness of the operation. Inquiries regarding Houston Fearless display devices will be given immediate attention. Scientists and engineers wishing to join in this advanced work will receive every consideration. Westwood Division HF Houston Fearless Corporation, 11801 West Olympic Boulevard, Los Angeles 64, Calif.

To recall a bullet 12,000 miles away



requires Motorola systems reliability

THE B-70 M&TC major system management contract places in the hands of a single contractor, Motorola, an unprecedented responsibility: positive recall of a Mach 3, nuclear deterrent force. At speeds over 2,000 mph – faster than a rifle bullet – crew and aircraft safety, as well as mission success, demand integration of myriad electronic functions with simplified controls and displays. ☆ The integrated M&TC system includes the functions of world-wide command communications (LRR) linked to the SAC Command Network; line-of-sight, short-range communications (SRR); improved tactical air navigational aids (TACAN); air-by-air IFF; air-by-ground IFF; aerospace ground support equipment (AGE); air-to-air rendezvous equipment; instrument landing system (ILS); and crew intercommunications. ☆ Motorola's role as a major electronic system contractor for the B-70 Valkyrie's Mission and Traffic Control typifies its systems management capabilities. Detailed information is available on request.

Military Electronics Division **MOTOROLA**

Qualified technical personnel are invited to apply

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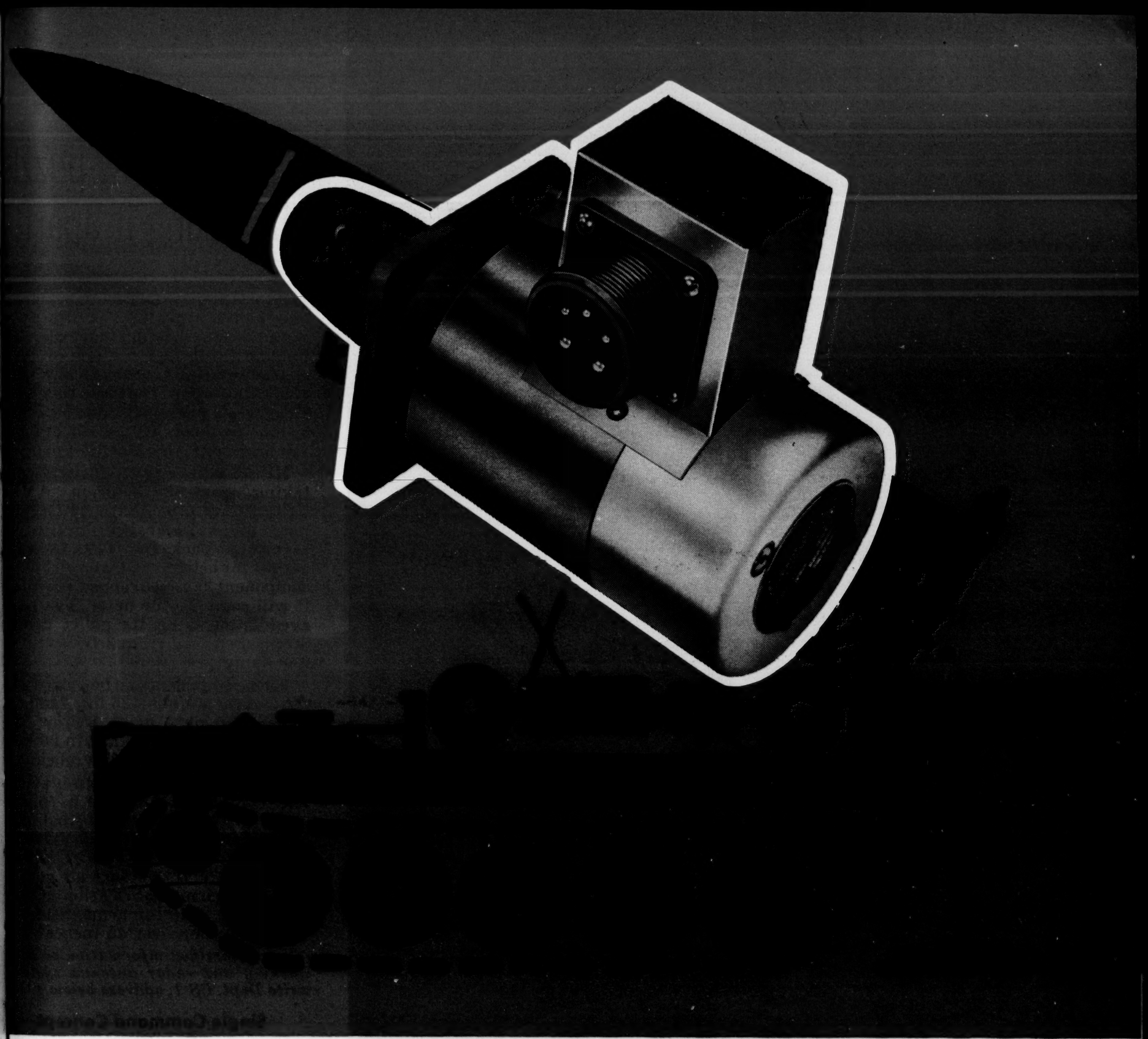
RIVERSIDE, California, 8330 Indiana Avenue



HYDRO-AIRE DEVELOPS NEW HIGH-PRESSURE, MINIATURE HYDRAULIC POWER PACKAGE FOR PERSHING, OTHER AIRBORNE APPLICATIONS

This new integrated pump-motor offers the smallest displacement of any high-pressure unit in the industry. It exhibits over-all efficiencies of 57-62%, weighs just 4.0 lbs. and measures only 3 by 4.5 by 6.5 inches. A common shaft and bearing arrangement contributes simplicity, reliability, and weight savings to a design with rated delivery of 0.34 GPM minimum at 3250 psig over 25.5 to 30 VDC. This is but one of a number of hydraulic power packages available at Hydro-Aire and applicable to a wide range of plug-in airborne control systems. If you have such an application, write Hydro-Aire for a prompt quote.

HYDRO-AIRE CAPABILITY BROCHURE. Write on your letterhead for a free copy.

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3000 WINONA AVENUE
BURBANK, CALIFORNIA

Developers and producers of reliable control components, sub-systems and systems for the aircraft, missile, electronic, and transportation industries.

DIVISION OF CRANE CO.

He solved this puzzl by taking it apart!

Like oil and water, extreme pre sion and "complete" mobility res combination in tracking radar a tennas. Designing for one of the characteristics "automatically" p cludes the other. *That* was this AM Engineer's puzzle—to put *both* p cision *and* mobility in an anten for duty with the Marine Corps.

He solved the puzzle, literally, taking apart the solution- AM TPQ-10 antenna—into 10 rugg portable, submersible, precisio fabricated packages. TPQ-10 is signed for helicopter transport. Ea component can be dropped in wat it will come up for more. The pa aged antenna on its pallet can dropped on land from 3 feet with impairing precision.

Each component can be *picked* u the largest weighs 425 lbs.—and c be handled by 3 men. A crew o can put TPQ-10 together in 20 m utes with one standard wrench.

Among the design innovatio that solved the puzzle is a "pig back" gear arrangement that p both azimuth and elevation drive one package. Result: almost half parts and weight of separate com nents. Precision fabrication is ty fied by the reflector arms, held t .005" deviation over 45 inches!

(For unclassified information on e warning and radar antenna syste write Dept. CS 1, address below.)

Single Command Concept

Solving puzzles with next-to- possible conditions is AMF's b ness. AMF's imagination and sk are organized in a single operatio unit offering a wide range of en neering and production capabilit It accepts assignments at any st from concept through developm production and service training, completes them faster ... in

- *Ground Support Equipment*
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- *Range Instrumentation • Radar*
- *Space Environment Equipment*
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In engineering and manufacturing AMF has ingenuity you can use . . . **AMERICAN MACHINE & FOUNDRY CO**

March 27, 1961

Aviation Week and Space Technology

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PICTURE CREDITS

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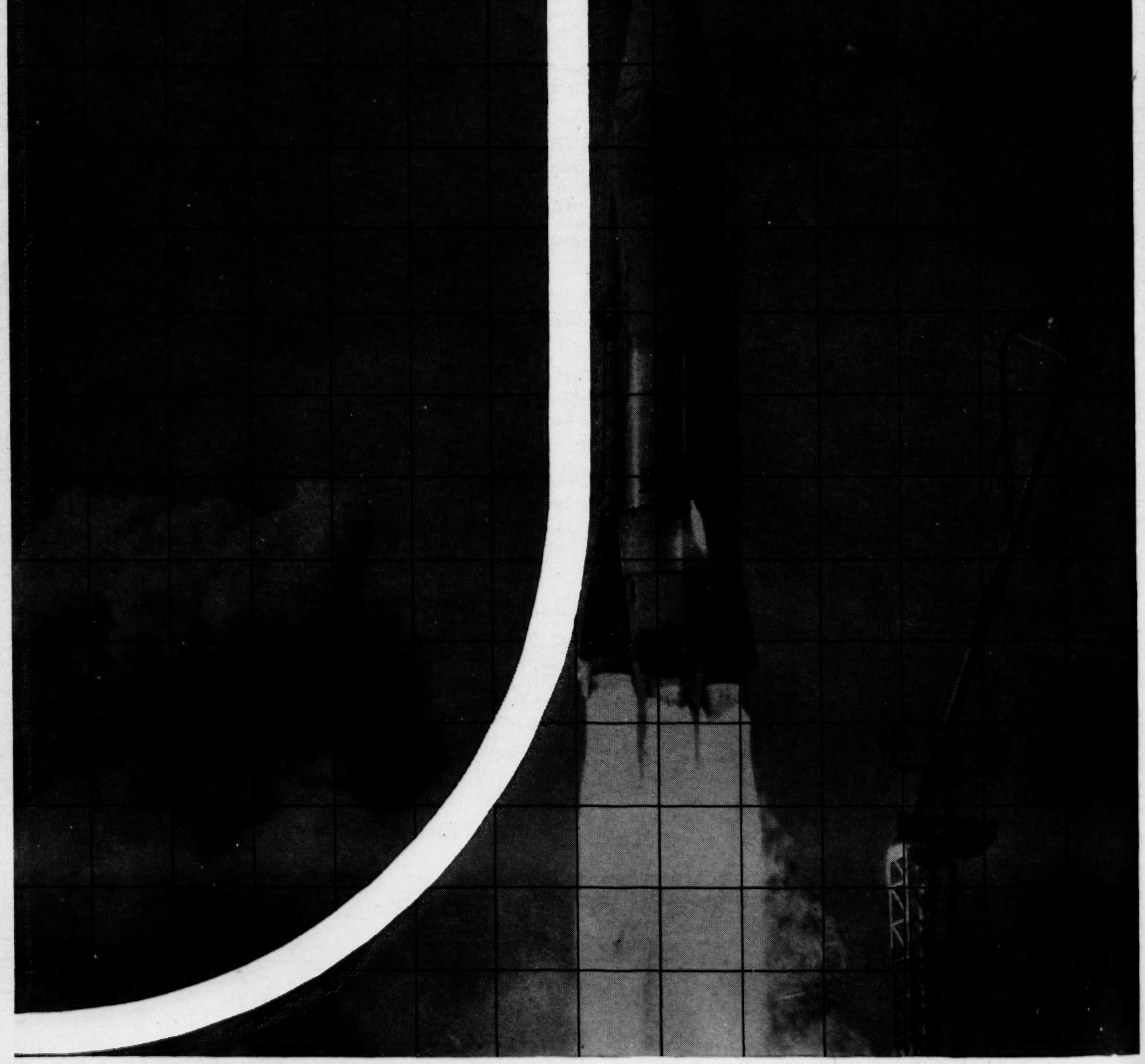


EDITORIAL

New Pattern Emerges

Establishment of the new USAF Systems Command (see p. 22) marks the end of a decade of evolution and struggle that began with a historic Air Council meeting on Jan. 3, 1950, when the late Gen. Muir Fairchild formally announced the decision to form an Air Research and Development Command and establish a voice for research and development at the air staff level. At this time, USAF was already being rocked by the technological revolution that has dominated the past decade and shows no signs of abating in the future. For those who could see the straws in the technical wind, it was evident that USAF's basic single line of development aimed at airplanes that could fly higher, faster, farther and carry heavier loads was about to fan out into an incredibly broad technical spectrum that would defy the efforts of any traditional military command structure to understand or manage it effectively.

In 1950, USAF's meager research and development facilities were scattered through a half dozen commands and had no central direction. The largest single bloc of technical talent lay in the old engineering division of the Air Materiel Command at Dayton. It was inevitable that wrenching this talented group out of AMC into the new command sowed many of the seeds for the decade of AMC-ARDC discord that we hope has now ended.

The strong technical tide ran against AMC philosophy. It became clear that USAF's prime problem no longer would be the production of thousands of aircraft of a single type involving hundreds of suppliers of standardized parts and components. Increasing pressure of the technical revolution made it inevitable that USAF weapon systems would evolve into increasingly complex items capable of enormous performance improvements. But because of the combination of their increased mission effectiveness, enormous cost and shorter obsolescence cycle, they would be produced in such relatively small quantities that they would never really emerge from the development cycle into the traditional standardized mass production runs.

At the same time, the Soviet Union's increasing technical challenge emerged and made it imperative that new management techniques be found to compress the time cycle from development to operational readiness sufficiently for the new weapons to be significant in the world balance of power. From this urgency developed the ARDC philosophy of concurrency that has been the hallmark of Ballistic Missile Division operations and will continue as the dominant policy of the new Systems Command.

The role of basic research that had been virtually ignored under the pre-1950 USAF organization began to emerge slowly, painfully but surely in the new ARDC organization. Its elevation to the status of a separate unit reporting directly to the USAF Chief of Staff is certainly a progressive step for this increasingly important function of exploring for basic new knowledge.

During the early years of ARDC, the larger and more powerful AMC fought hard to strangle this lusty infant before it grew too muscular for parental dominance. During the mid-decade period, there were some sincere but never very effective attempts to glue the two organizations together in critical areas through such devices as the joint Weapon System Project Offices at Dayton, where ARDC and AMC officers worked side by side to manage specific systems. But except for a brief period when Gen. Edwin Rawlings headed AMC and Gen. Thomas Power commanded ARDC and they personally caulked the worst of the spreading seams, the ARDC-AMC feud flared and sputtered to no good purpose.

The ICBM program was the first real test of ARDC's effectiveness, and thus it is not surprising that the current dominance of the command has evolved under the leaders who organized and managed that program in the Ballistic Missile Division of ARDC. It is also significant that the complexities and urgency of the ICBM program provided the strain that made the increasing inadequacies of trying to weld ARDC and AMC capabilities into a single national effort most painfully obvious and critical, and that sparked the reorganization which produced the new Systems Command.

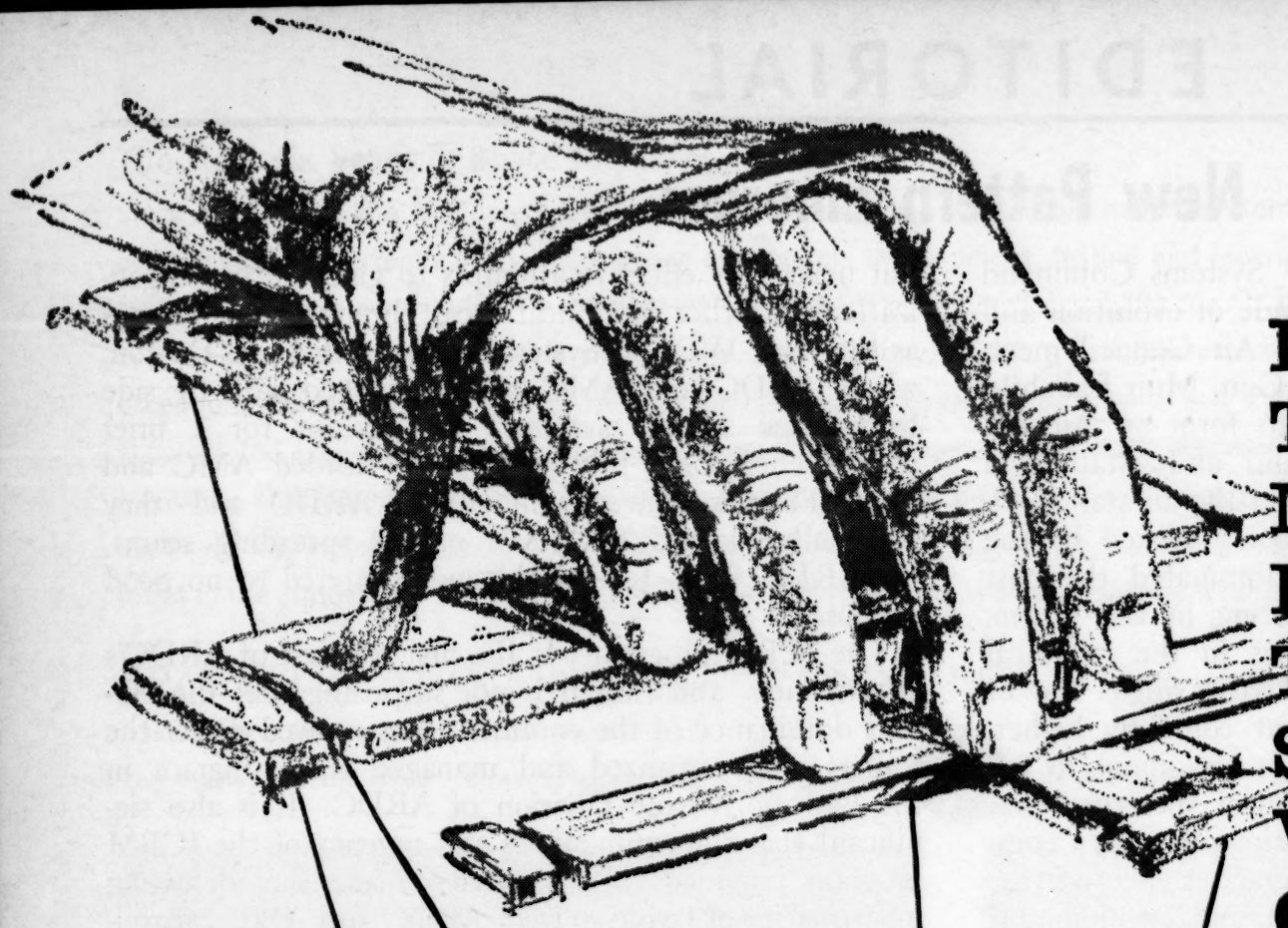
Certainly the assignment to the new Systems Command of full management responsibility for weapon system development through the spawning cycle to full operational readiness is a solid attempt to eliminate the gaps in management and responsibility that yawned too often between AMC and ARDC in the past. It is hard to quarrel with the management philosophy that combines responsibility and authority in a single executive hand. Industry, which has so often played the unenviable role of the shuttlecock in the ARDC-AMC badminton game, will certainly welcome a change that eliminates duplicate management layers and affixes authority in clearly defined channels.

AMC may feel it has suffered a loss of face in losing the final and decisive battle with ARDC, but we believe it will find ample work to occupy its energies with refining the techniques for global logistics and applying the advancing techniques of the computer and airlift to provide more effective and less costly logistic support for USAF's far-flung combat organizations.

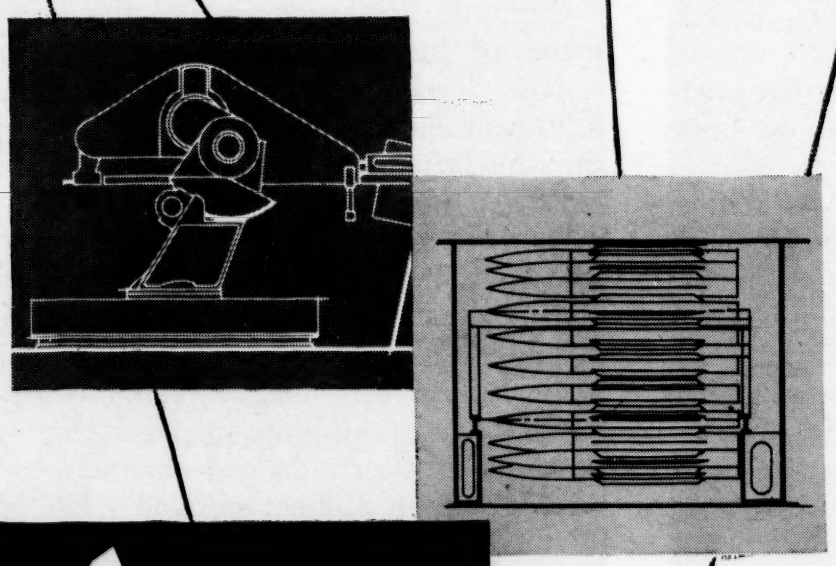
Although most of their efforts in the early days of the fight to establish research and development in a position to provide USAF with the fruits of the technical revolution are now all but forgotten, it is worth recalling the sound technical vision and courage of the small group of men who fought military traditionalists so hard to open the door for ARDC and the Systems Command —among them the late Louis Ridenour, Jimmy Doolittle, Trevor Gardner, the late John von Neumann, Don Putt, Guy Stever and Theodore von Karman.

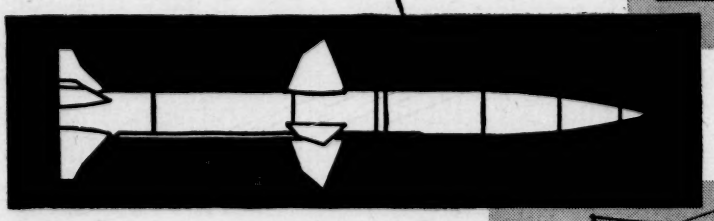
USAF has taken what looks like an intelligent and decisive step to solve a management problem whose continued festering could endanger the entire nation and cause an unnecessary economic drain on defense resources. The new Systems Command will assume an awesome responsibility, but USAF will apparently back it with adequate authority and resources. The nation will be watching closely to see how well it does its job.

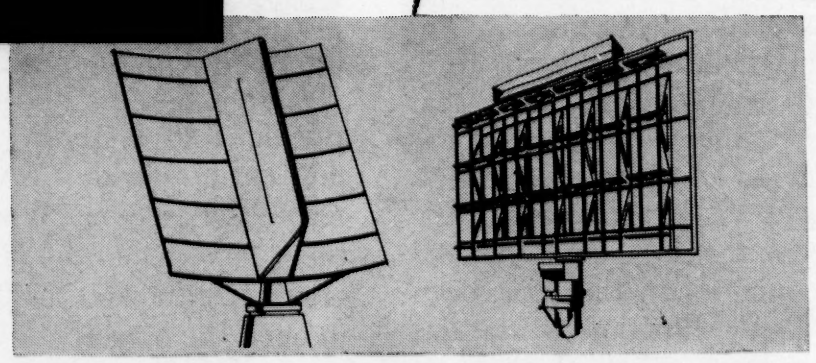
—Robert Hotz



IT'S THE MAN BEHIND THE SCENE WHO COUNTS







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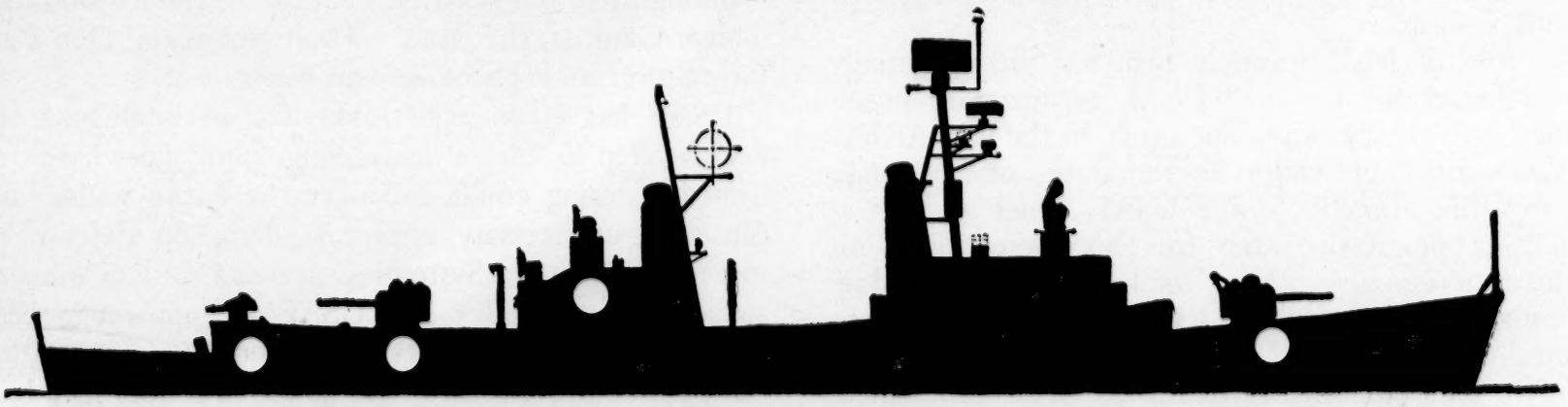

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WHO'S WHERE

In the Front Office

William M. Smith, vice president and manager, Rockets Division of Bell Aerosystems Co., Buffalo, N. Y., succeeding **James N. Davis** who resigned to accept an appointment with the Department of Defense. Also: **Frank H. Andrix,** assistant vice president and director of engineering, Avionics Division.

Larry Decker, vice president-traffic and sales, Bonanza Air Lines, succeeding **William J. Mitchell,** resigned.

Donn L. Williams, vice president and general manager, Armament and Flight Control operations of Autonetics, a division of North American Aviation, Inc., Downey, Calif. Also: **C. A. Wolf,** vice president and acting executive-in-charge of Central Administration; **R. L. Olson,** vice president and acting assistant general manager, Armament and Flight Control.

A. G. Heckman, executive vice president, Babcock Electronics Corp., Costa Mesa, Calif.

Leo A. Pfankuch, a director of Telecomputing Corp., Los Angeles, Calif. Mr. Pfankuch is president of Shur-Lok Marine Corp.

J. J. O'Brien, a director of the Garrett Corp., Los Angeles, Calif. Mr. O'Brien is manager of the company's AiResearch Manufacturing Division in Arizona.

William Donner Roosevelt, a director of Electronic Communications, Inc., St. Petersburg, Fla. Mr. Roosevelt is manager of the Denver operations of Standard Products, Inc., a subsidiary.

E. H. van der Beugel, president of KLM Royal Dutch Airlines succeeding **I. A. Aler,** retiring. **F. Besancon** succeeds Mr. van der Beugel as deputy president.

Robert F. Halligan, president of the Hallicrafters Co., Chicago, Ill., succeeding **William J. Halligan, Sr.,** who continues as board chairman and chief executive officer. **Stanley E. Rendell** succeeds R. F. Halligan as executive vice president and general manager.

Dr. Donald M. Allison, Jr., president of Vitro Electronics, a division of Vitro Corporation of America, New York, N. Y.

L. Dennis Shapiro, president of Aerospace Research, Inc., Cambridge, Mass.

Charles E. Heitman, Jr., a vice president and a member of the administration committee, the Bendix Corp., Detroit, Mich. Mr. Heitman continues as group executive in charge of the Bendix Products Division, and the Sheffield Corp., a subsidiary.

Robert P. Dutton, vice president-government representation, Collins Radio Co., Cedar Rapids, Iowa, with offices in Washington, D. C. Also: **Edward A. Williams,** vice president-operations control for Collins Radio.

Donald L. Driscoll, vice president-marketing, American Avionics, Inc., a division of Astro-Science Corp., Los Angeles Calif.

Kenneth M. Miller, vice president and general manager, Daystrom-Pacific, Los Angeles, Calif., a division of Daystrom, Inc.

G. Richard Tingley, vice president, Military and Industrial Systems Department, CBS Laboratories, Stamford, Conn.

(*Continued on page 103*)

INDUSTRY OBSERVER

▶ Ten test flights are scheduled in 1962-63 as part of the effort to check out the Army's Project Advent communications satellite. First three launchings will use the Agena B, and the other seven will be made with the Centaur upper stage.

▶ **NASA will ask the Air Force to fly its research payload containing a chimpanzee and two monkeys in an Agena satellite if the vehicle can meet requirements before the space agency's Mercury capsule can be used with an Atlas booster. Agena would have to be able to put 500 lb., including environmental instrumentation and food, into orbit for 14 days. NASA has given the University of California a $90,000 contract to develop some of the components of this adaptable 500-lb. package.**

▶ Air Force believes that the surprising success of its first free-flight firing of the Minuteman missile may allow it to eliminate 8-10 test shots from the development schedule. Structural weight and probably the amount of protective heat coating at upper ends of the first and second stages will be reduced before the next missile is fired.

▶ **Recent analysis of meteorites has revealed unusual electric properties, unlike those of any known terrestrial material, which resemble characteristics of semiconductors—despite the fact that meteorites do not have the single-crystal structure of conventional semiconductors. Conductron Corp. has been formed at Ann Arbor, Mich., to investigate these meteorite properties and the prospects of synthesizing a new type of transistor.**

▶ Air Force medical researchers are planning studies of automatic response devices to cope with flashes of high-intensity light to avoid the temporary blindness or permanent damage to the eyes of air and space crewmen.

▶ **Boeing is expected to request bids within the next two months on ground support equipment for the Dyna-Soar glider. Work statement of the proposal request will be based largely on the results of a comprehensive company survey of ground support equipment now available from Autonetics, Bendix, Goodyear, Minneapolis-Honeywell, Nortronics and RCA.**

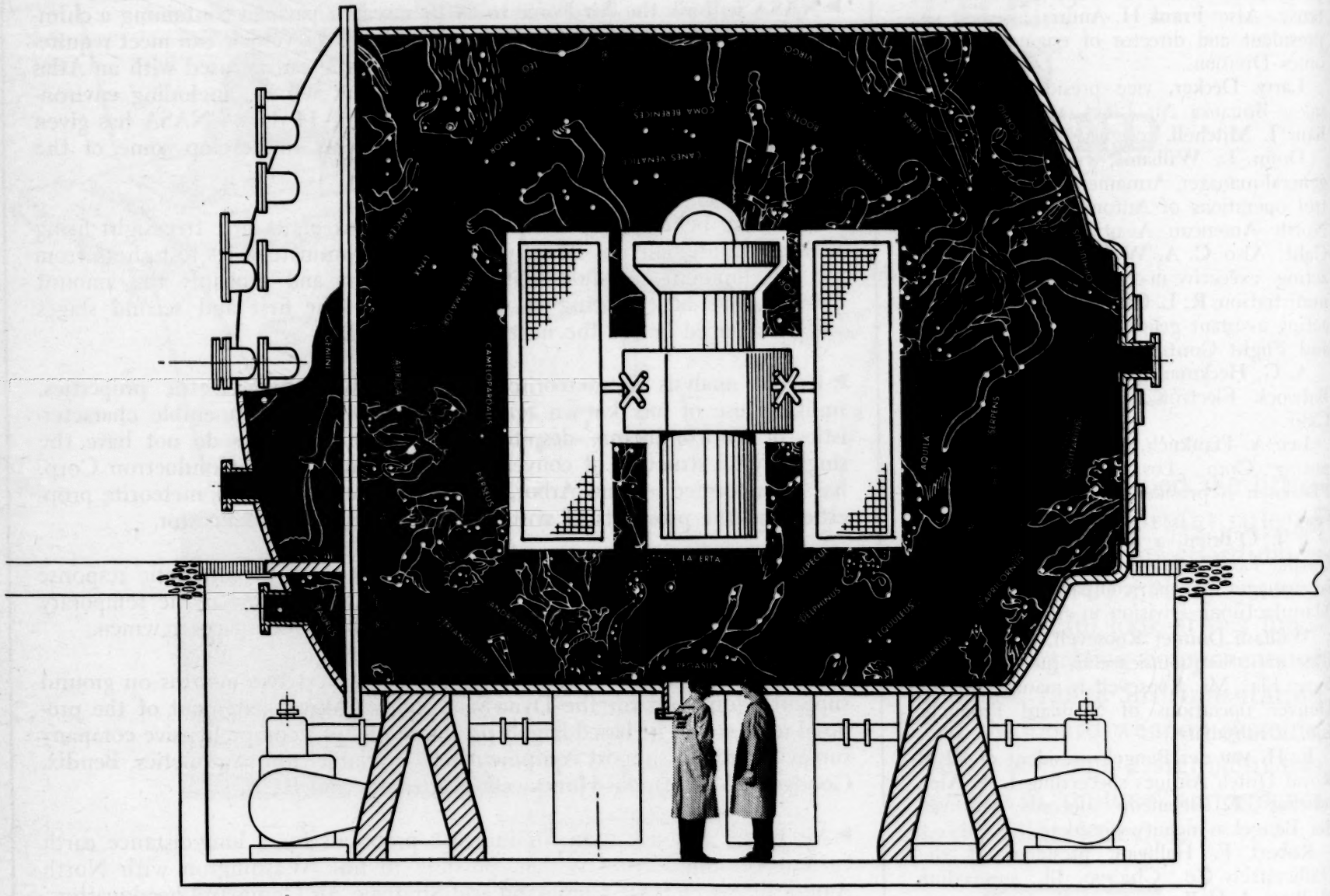
▶ Air Force may ask soon for industry proposals for a long-distance earth current communication system, possibly to link Washington with North American Air Defense Command and Strategic Air Command headquarters. Earth current technique originally was developed as a communications link between Minuteman ICBM silos and their central command post, but it now appears suitable for long-range communications.

▶ **NASA will launch the first three Saturn vehicles, which have dummy upper stages, from Complex 34 at Cape Canaveral. The next few shots will be made from Complex 37, which is being built with liquid-hydrogen facilities, while Complex 34 is being equipped with hydrogen capability to handle the Saturn liquid-hydrogen fueled upper stages.**

▶ Air Force will request proposals soon for a command and control system (425-L) for the new North American Air Defense Command hardened control center near Colorado Springs, Colo.

▶ **"Foamed" concrete formed under pressure may find wide use in flame deflectors for missile launching pads. In three firings of the Atlas-Agena A vehicle from Pt. Arguello, Calif., heat from the 360,000-lb. thrust booster has removed only 0.25 in. of the concrete flame deflector's surface. This method eliminates the need for heavy steel flame buckets and the thousands of gallons of water required to cool them. New Complex 36 at Cape Canaveral, from which Atlas-Centaur will be launched, uses a concrete deflector.**

▶ Air Force has notified North American that the B-70 flight-test program will be conducted by USAF crews, including the first flight. Company crews will "participate" in the program. This is similar to the approach on Dyna-Soar, and it is part of an Air Force effort apparently aimed at eliminating company participation in weapon system flight testing.



SATELLITE IN DRESS REHEARSAL. This 20 x 27 foot, high-vacuum chamber now under construction is the newest addition to our series of chambers for complete space system development, assembly, and test at a single location. Full-size spacecraft will operate in this chamber as in orbit. Satellites will be subjected to both simulated solar glare and the chill of space darkness. They will also experience launch and boost conditions, and structural and thermal loads. Career opportunities are open to better engineers and scientists to staff this expanding space laboratory.

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Washington Roundup

Trudeau's Retreat

Kennedy Administration's attempts to keep its officials from publicly criticizing policy passed another milestone last week when Lt. Gen. Arthur G. Trudeau, chief of Army research and development, issued a public apology for a sarcastic remark about "the great civilian minds" who conceived the directive giving Air Force most space development work (see p. 26). Gen. Trudeau said he was "deeply disturbed" that the remark had given "the impression that I intended to criticize my civilian superiors."

NASA hopes to spend several million dollars in Fiscal 1963 for a new life sciences laboratory at the Ames Research Center, in addition to the $800,000 it has requested in Fiscal 1962 to modify existing facilities there and equip them for life sciences research.

Although the new Administration has assured Congress that its revisions in the civilian space budget won't substantially change the proposed Eisenhower total of $1.12 billion for Fiscal 1962, program officials within National Aeronautics and Space Administration wanted increases in propulsion, manned space flight and planetary flight projects that would have raised the total by $300 million, or some 27%.

Questionnaires on the economic impact of arms control on the domestic economy were returned by a surprising 99% of the 139 large defense contractors queried by the Senate Foreign Relations Disarmament Subcommittee (AW Feb. 13, p. 26). Answers from these and 250 other large and small firms are being tabulated. Evaluation of the statistics that result will require several weeks.

Project Horizon

Project Horizon, the task force created by President Kennedy to study national aviation goals, established headquarters in Federal Aviation Agency's main offices here last week. Fred Glass, who heads the group, named Stanley Gewirtz, recently resigned vice president of Western Air Lines, as his top operating official. William Littlewood, American Airlines vice president, will serve as a consultant. Paul Reiber, formerly with the Air Transport Assn., will handle international phases of the study.

Air Force is expected to try immediately for an official altitude record with the X-15 rocket research aircraft now that Defense Department has eliminated the five-year-old requirement that aircraft must be in operational service for six months before record attempts are made. A planned attempt for a climb-to-altitude record with the Northrop T-38A was canceled without explanation. Restrictions on B-52Gs because of wing strength trouble have prevented it from trying for the non-refueled distance record.

Secretary of Commerce Luther Hodges has proposed ending the secret briefings that government officials give to the 175 business representatives who sit on the Department's Business Advisory Council. Hodges also would like to broaden representation on the council, now composed chiefly of presidents of larger firms, and to make it more a working group that would feed back more advice to government on general economic policies.

Dr. Harold Brown will begin working about half time as Defense director of research and engineering next week and expects to take over completely from Dr. Herbert F. York by May 1.

Contract Probes

Hearings on defense contract overcharges are to begin this week before the House Armed Services Investigating Subcommittee, with the Comptroller General as lead-off witness. Main concern of Chairman Edward Hebert is to what extent contractors have repaid charges that the General Accounting Office has said were excessive.

One aim of the subcommittee's current exploration of so-called "effort" contracts between government and non-profit research and management firms is to ascertain whether public policies and decisions are substantially influenced by private concerns. Hearings on these "think" contracts are expected in about a month.

Sen. Stuart Symington is expected to name James J. Gehrig, an engineer from Northrop's Norair Division, as his defense and space adviser to replace Edward C. Welsh, who has been named to the space council staff (see p. 29).

Chairman Robert Kerr's plan to create subcommittees of his Senate space committee now appears to be in doubt. No major investigations or hearings are expected other than on amendments to the space act that would allow Vice President Lyndon Johnson to serve as chairman, and on appointments to the council.

—Washington Staff

USAF Will Form New Systems Command

Development command will become nucleus, gaining procurement of major weapons from AMC.

By Larry Booda

Washington—Air Force is creating a new Systems Command that will serve as a single agency to control its aircraft, missile and space systems from the beginning of their development until they are in the field ready for operational use.

Until now, this responsibility has been divided between the Air Research and Development Command and the Air Materiel Command. In essence, the new command will consist of the old ARDC with the procurement and production functions of AMC added to it, and AMC will be re-named the Air Force Logistics Command.

The move is being made partly to answer criticism of the way Air Force has handled construction and activation of intercontinental ballistic missile sites, and partly to provide better all-round management of all types of weapon systems.

It represents a personal victory for Lt. Gen. Bernard A. Schriever, commander of ARDC, who will head the new command. It also represents the end of a 10-year cycle that began when ARDC was created to remove research and development from the dominating influence of procurement and production. As the pace of technology continued to accelerate, ARDC grew in strength to the point where it now is taking the procurement and production of major weapon systems away from AMC.

The new command, which will be completely formed by July 1, also follows recommendations of President Kennedy's space task force, headed by Dr. Jerome B. Wiesner, which reported to the President earlier this year (AW Jan. 16, p. 26) that "the nation's ballistic missile program is lagging . . . We believe that re-establishing an effective, efficient, technically competent management for the program is the overriding necessity."

Streamlining Move

Considered in combination with the recent directive giving USAF responsibility for most space development work, establishment of the new command also represents a streamlining of military space program management.

Most basic research and some applied research will be spun off from ARDC and centered in a new Office of Aerospace Research, which will report directly to the chief of staff. This also is the culmination of a 10-year effort by USAF supporters of basic research to elevate the work to an echelon where it would not suffer from the fact that more immediate development problems demanded most of the attention and funds.

The Air Force Systems Command will have its headquarters at Andrews AFB, Md., near here, and the Air Force Logistics Command will have headquarters at Wright-Patterson AFB, Ohio. It will be headed by Gen. Samuel E. Anderson, who is now head of AMC, and will operate and control the worldwide logistics systems that support the Air Force.

The Systems Command will have four major divisions—two of them located at Inglewood, Calif., under a deputy commander for aerospace systems, and two reporting directly to headquarters, with no deputy commander. The two Inglewood divisions are:

- **Ballistic Systems Division,** which will be composed of elements of BMD, AMC's Ballistic Missile Center, and the Ballistic Missile Office of the Army Corps of Engineers.
- **Space Systems Division,** which will also be composed of portions of BMD and BMC, plus representatives of other services concerned with space programs.

Reporting directly to headquarters will be:

- **Aeronautical Systems Division,** which will be composed of most of what is now the current ARDC Wright Air Development Division and the AMC Aeronautical Systems Center. The division will be located at Wright-Patterson AFB.
- **Electronics Systems Division** which will be located at Hanscom AFB, Mass. This will be a combination of the Command and Control Development Division of ARDC and the AMC Electronics Systems Center.
- **Six test centers,** formerly under ARDC, will be transferred to the new command. They are the Flight Test Center, Edwards AFB, Calif.; Missile Development Center, Holloman AFB, N. M.; Missile Test Center, Patrick AFB, Fla.; Special Weapons Center, Kirtland AFB, N. M.; Air Proving Ground Center, Eglin AFB, Fla.; and Arnold Engineering Development Center, Tullahoma, Tenn.

Although members of Gen. Schriever's staff, located principally in the office of Deputy Chief of Staff for Research and Engineering Maj. Gen. Marcus F. Cooper, had been working on a reorganization plan for some time, the final spur to their efforts came when Rep. Harry Sheppard (D.-Calif.), chairman of the House Appropriations Military Construction Subcommittee, charged that the missile base construction program is in "a terrible mess."

Another reason for their efforts was the recently issued directive which strengthened the role of the Air Force in the space mission.

Since the ARDC plan, prepared by Col. Otto J. Glasser, Col. J. T. Stewart and Col. J. C. Maxwell, already was prepared, the chief of staff directed that it be used as the basis for the new plan. Although the final result was a compromise, it reflected many of the ideas of Gen. Schriever, who probably will be promoted to full general after the change takes effect July 1.

In terms of civilian and military personnel, the new command will have approximately 60,000. AMC will lose 14,000 in the transfer, but, as the Logistics Command, will still have 165,000 people. ARDC strength as of Jan. 1 was 45,153, including some 6,300 officers, 15,500 airmen and 23,400 civilians.

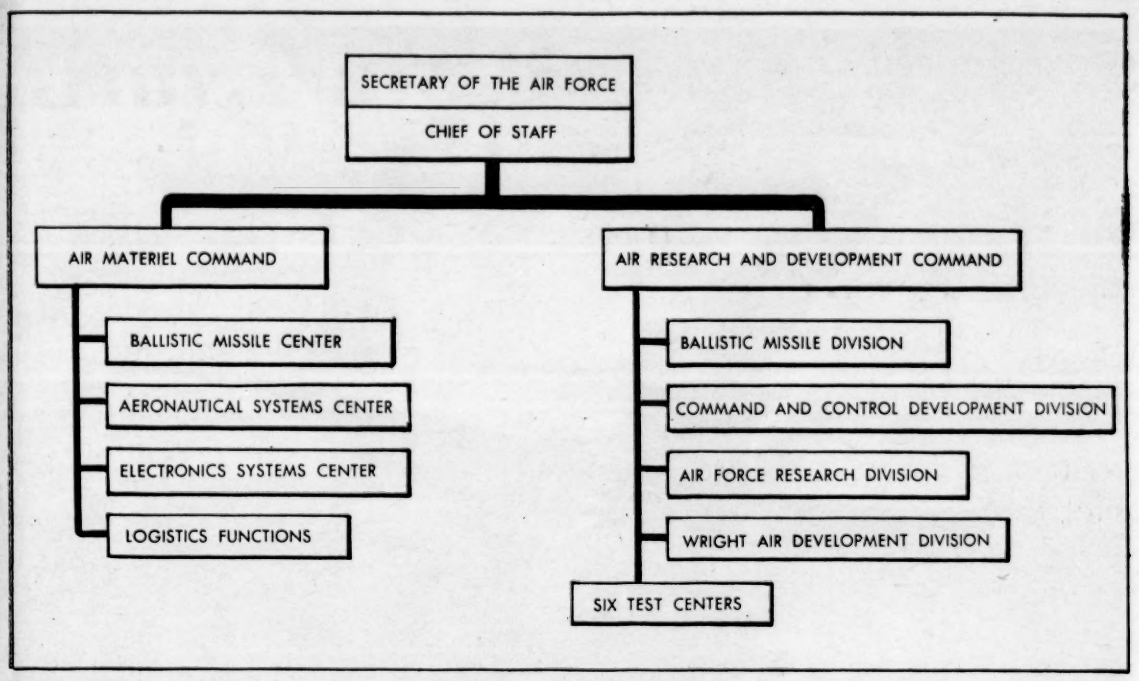
About 30% of the procurement money now handled by AMC will go to the Systems Command—$3.2 billion in Fiscal 1962 and $2.2 billion in Fiscal 1963.

Headquarters Strength

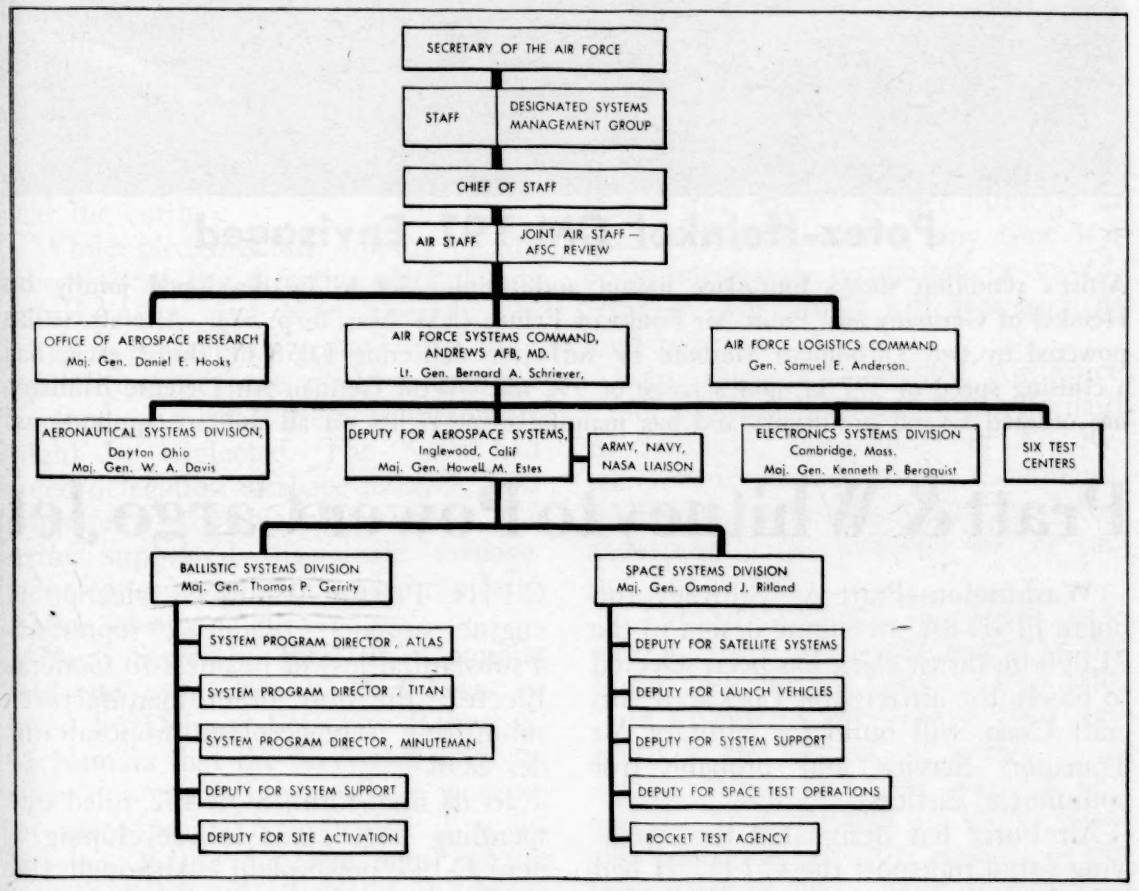
Present ARDC headquarters strength is 1,150. Although no estimate has been made of how the reorganization will affect this, Gen. Schriever believes generally in decentralization of authority and responsibility. This was reflected in ARDC shifts in the past two years which saw system management responsibility shifted down to the division level. Little increase in the Systems Command staff at Andrews can be expected.

Maj. Gen. Howell M. Estes, now assistant deputy chief of staff for operations, will be deputy commander for aerospace systems, located at Inglewood, Calif. Assistant deputy commander will be Maj. Gen. Joseph R. Holzapple, present commander of WADD.

Under Estes will be Maj. Gen.



PRESENT USAF structure for development and acquisition of major weapon systems.



NEW STRUCTURE for weapons systems management, which will be in force by July 1.

Thomas P. Gerrity, who presently is commander of BMC, as commander of the Ballistic Systems Division, and Maj. Gen. Osmond J. Ritland, present head of BMD, as commander of the Space Systems Division. Deputy to Ritland will be Brig. Gen. Robert E. Greer.

Reporting directly to Systems Command Headquarters will be Maj. Gen. W. Austin Davis as head of the Aeronautical Systems Division. He is now head of AMC's ASC at Wright-Patterson. For the Electronics Systems Division the commander will be Maj. Gen. Kenneth P. Bergquist, now commander of ARDC's CCDD.

Present commander of the Air Force Research Division, Maj. Gen. Daniel E. Hooks, will head the Office of Aerospace Research.

Each of the new divisions will have representatives of using commands, such as Tactical Air Command, Strategic Air Command and Military Air Transport Service, on the staff to monitor the tasks of their organizations.

When an AFSC division is doing work for other services, representatives of those services will participate. The Logistics Command will be represented and will participate in support functions.

Operations of the Ballistic Systems Division will be a representative example of the others. The commander will have available all resources required for development, test, evaluation, procurement, production, site activation and planning for support and operation of ballistic missiles.

He will have as his deputy Army Brig. Gen. A. C. Welling, who presently heads the Corps of Engineers office in charge of site construction. For the first time, direct military control of the construction function will be held by an Air Force commander. Welling will have both Army and Air Force officers reporting to him. Currently the construction program is run on a cooperative basis. The new line of authority was planned with the consent of the Army and may indicate a trend for other Air Force-Army construction operations.

Each site activation task force, formerly under AMC, will be combined with ARDC and Corps of Engineers detachments as integrated site activation task force (SATAF) teams under the BSD commander.

Aerospace Research Office

The present Air Force Research Division with its field offices—the Air Force Office of Scientific Research here, the Aeronautical Research Laboratory at Wright-Patterson AFB, and the Cambridge Research Laboratories at Hanscom Field, Mass.—will form the Office of Aerospace Research.

Unresolved in the new plan is the relationship of the Aerospace Medical Center at Brooks AFB, Texas, which is under the Air Training Command. There are bioastronautics and aviation medical representatives on every staff where the human factor is involved. Much of the research in this field is done at Brooks.

Secretary of the Air Force Eugene M. Zuckert explained that the Brooks activity would be "very closely coordinated." There is a possibility, however, that the center could eventually become a division of the systems command.

In placing research directly under the chief of staff in the form of the Office of Aerospace Research, the Air Force has taken the same research organization approach as the Army and Navy.

Research Mission

In describing its mission, Dr. Joseph V. Charyk, under secretary of the Air Force, said: "The office . . . could well be involved in the study of techniques which at some stage of the game would indicate the possibility of accomplishing an important military job in space.

"So there might well be outgrowths from the Office of Aerospace Research that would lead to space projects. On the other hand, the Space Systems Division will also be engaged in applied research relative to space systems, and of course, will conduct all the supporting research for Air Force systems."

Office of Aerospace Research also is expected to engage in applied research and these activities will be coordinated with the system commands.

Although determination of the divi-

sion of activities involved in forming the current BMC and BMD into the new Ballistic Systems Division and Space Systems Division was the subject of conferences at Inglewood last week, certain shifts appear logical.

Moving to Ballistic Systems Division from BMC will be the site activation task forces, the directorate of ballistic missiles and most of the directorate of systems support. From BMD will come the activities under the deputy commander for ballistic missiles and the deputy commander for civil engineering, except the director of space systems engineering.

Shifting to the Space Systems Division from BMC will be the directorate of space and satellites, composed of a space studies division, a satellite division and an advanced systems division. Space engines support will also go to SSD. From BMD will come the deputy commander for space programs, whose organization includes boosters, defense, communications, bioastronautics, and a Huntsville, Ala. office. Under civil engineering, the director of space systems engineering will go to SSD.

The administrative organizations of BMC and BMD do not lend themselves to transfer intact. There will have to be piecemeal shifting of personnel and offices such as personnel, manpower, plans, management, procurement and production, logistics, judge advocate, inspector general, intelligence, etc.

Some of the philosophy which has gone into the new plan was reflected in the report of a special ARDC task force on reorganization which Schriever organized in 1959 and which submitted its report July 31.

It stated that development of useful military systems must be conducted within a philosophy of concurrency, with all elements of a total military system funded in an integrated manner and developed concurrently under a single plan. First steps at following such a system was the adoption of the PEP management system for several programs. This was based on the Navy's PERT system applied to the Polaris missile (AW Nov. 28, p. 85).

Too much headquarters effort was spent on peripheral, and second and third echelon tasks, the report said, and decentralization was carried out with the formation of four divisions. There is a lack of clear, vertical decision-making channels, an uncoordinated variation in the assignment of priorities and allocation of resources at all levels, and confusion arising out of a lack of clear definition of responsibility and authority, it said.

Monitoring the whole research, development and acquisition effort of the Air Force for the Secretary is a designated systems management group reporting directly to him.

Potez-Heinkel CM-191 Envisaged

Artist's rendition shows four-place liaison and training jet to be developed jointly by Heinkel of Germany and Potez Air Fouga of France (AW Mar. 6, p. 37). Aircraft, to be powered by two Turbomeca Marbore IV turbojets, delivering 1,058 lb. thrust each, has a cruising speed of 377 kt. and a range of 932 mi. West German Air Defense Ministry has ordered several prototypes and has manufacturing rights on all military applications.

Pratt & Whitney to Power Cargo Jet

Washington—Pratt & Whitney turbofan JT3D-8A, an engine design in the 21,000-lb.-thrust class, has been selected to power the airfreighter Lockheed Aircraft Corp. will build for Military Air Transport Service and probably for commercial carriers.

Air Force has designated the swept-wing cargo transport the C-141. It had been known variously as the SOR-182, SS476-L and CX-1 (AW Mar. 20, p. 24).

Air Research and Development Command and Air Materiel Command will negotiate the first SOR-182 contract with Lockheed as the next step leading to development and production of the C-141. Meanwhile, the airframe manufacturer probably will act in a consultant's role as Air Force deals with Pratt & Whitney on design details and development of the new engine.

Growth potential of the JT3D-8A design is estimated at between 15 and 20%. Thus, the turbofan ultimately will be rated in the 24,000 to 25,000-lb.-thrust category if this potential is used.

A growth factor of 20% also was built into Lockheed's C-141 design.

Engine contracts are expected to represent slightly less than a third of the $1 billion that Air Force would like to see spent on a 132-aircraft fleet of C-141s. Pratt & Whitney's selection as engine supplier, therefore, represents a substantial loss of business to General Electric, the only other manufacturer submitting a powerplant proposal under SOR-182.

In its final form, SOR-182 ruled out spending large sums for developing a new C-141 powerplant. Although the JT3D-8A evolves from other turbofans in Pratt & Whitney's JT3D series, it is not an off-the-shelf engine. These two factors would seem to indicate that an Air Force effort to split development costs between the manufacturer and the government may be forthcoming.

Federal Aviation Agency, which monitored the SOR-182 project through the selection of Lockheed as airframe contractor, last week sent a team of engineers to the manufacturer's Marietta, Ga., plant. Because of commercial interest in the transport, FAA wants to ensure that the design will meet certification requirements of the Civil Air Regulations.

Several airlines already have asked Lockheed for briefings on C-141 cargo carrying capability and direct operating costs. However, all such requests have been deferred until Air Force and Department of Defense lift their ban on releasing detailed information about the aircraft.

Army, Navy Reluctantly Back Space Edict

By Ford Eastman

Washington—Top Army and Navy officials told Congress last week they "fully support" the Defense Department's edict giving the Air Force control of space development, but they reserved the right to object if their interests in space are neglected.

Defense Department's space policy directive (AW Mar. 13, p. 304) was investigated by the House Committee on Science and Astronautics to determine what effects such a directive might have on the choice of projects to be pursued, the system of priorities and the ultimate applications in both the military and civilian spheres.

Both the Army and Navy reaffirmed their contention that space is an environment, not a function, and that all the services should be permitted to use space in pursuing their missions on or near the earth.

While pledging full support to the execution of the directive after it was signed, Army and Navy strongly objected to it earlier on grounds that their capabilities in space might no longer be used and that their requirements might be neglected. The Navy had urged delegation of space research on a program-by-program basis, while the Army supported the single management concept—but not under the jurisdiction of any single service.

Navy Secretary John B. Connally told the committee he had been assured by Defense Secretary Robert S. McNamara that the Navy will be given every opportunity to continue working on space programs in which it is interested. If the directive does not result in the requirements of the Navy being met, he said, then, under the directive, exceptions would be made in order that the Navy might itself pursue these activities.

Gen. L. L. Lemnitzer, chairman of the Joint Chiefs of Staff, told the committee that the Joint Chiefs were not consulted about the directive, but that the individual chiefs of staff were asked for their comments. He said he suggested that current programs, particularly communications and navigation, should stay with the Army and Navy. He also told the committee that he feels development of systems should stay in the hands of the service that has a primary interest and that he could see "nothing in the directive that would change that."

Army Secretary Elvis J. Stahr, Jr., said he had no information that the provisions of the directive would be interpreted to interfere with the Army's requirements for the use of space which are peculiarly related to its primary mission.

However, Stahr added: "I assure you that if the Army's proper interests in space technology are at any time not being adequately recognized or served, Secretary McNamara will hear from us loud and clear."

Gen. Thomas D. White, Air Force Chief of Staff, and Lt. Gen. Bernard A. Schriever, commander of Air Research and Development Command, assured the committee that the letter and spirit of the directive will be carried out in full.

"The Air Force will bend over backward to meet the requirements of the Army and Navy," Gen. White said, "and we intend to carry out their programs to the best of our ability."

Gen. White and Gen Schriever also said the Air Force will use the facilities and talents of the other services to the fullest extent and "work shoulder to shoulder" with the National Aeronautics and Space Administration in the over-all national space program.

Deputy Defense Secretary Roswell Gilpatric told the committee that the purpose of the directive was to establish policies and to assign responsibilities for research, development, test and engineering of satellites, anti-satellites, space probes and their supporting systems for all elements of the Defense Department. Under this directive, he said, not only the services, but all Defense organizations are authorized to conduct preliminary research to develop ways of using space technology to perform their assigned functions.

The services and other units will not be given a free hand to conduct preliminary research as they see fit, however. The scope of such preliminary research, Gilpatric said, is to be defined by director of defense research and engineering in terms of expenditure limitations and "appropriate conditions."

No military department or Defense agency will be permitted to go beyond the defined scope of preliminary research "unless and until" the program has received the approval of either the defense secretary or the deputy secretary, he said.

Gilpatric told the committee that while the Army and Navy are free to propose space projects or programs related to their assigned missions on earth, he feels the two services already have a large research and development workload in modernizing weapons and improving anti-submarine warfare.

While Army and Navy witnesses attempted to appear satisfied and in agreement with the directive, doubt and dissatisfaction were apparent.

Army Secretary Stahr said: "We believe that the directive as it is drafted, and as we think it will work out in practice, gives us adequate scope to fulfill the Army's assigned and logical missions in the defense of this country. It can be made to work out well, or it can be made to work badly—time alone will tell."

Navy Secretary Connally said the key to whether the order will be good or bad for the defense effort depends upon how it is administered. "I assure you," he said, "that I will not hesitate to come here before this committee to sound the alarm if danger appears."

Both Stahr and Connally stressed that when a new program develops that is of primary importance to their respective services, they should be allowed to pursue it all the way through. They said they felt the exception clause pro-

No Pressure Suit

Moscow—Soviet test pilot Konstantin Kokkinaki, who Russia says flew an E-66 turbojet aircraft to a world speed record of 1,332 mph. over a 100-km. closed course last year, claims to have made the flight without a pressure suit. E-66 is believed to be an obscure designation for the Sukhoi delta-winged fighter.

Kokkinaki told Ogonyok magazine that on such a course, "you feel considerable overload" throughout the flight. But he said he flew without the pressure suit because "I don't like to fly in it. It bothers me, and to set a record the machine had to be piloted with very great precision."

NASA Relay Bidders

Washington—Seven companies and teams have submitted proposals for the Relay active communications satellite which National Aeronautics and Space Administration will use to test components for a commercial satellite communications system.

Bids were received from Bendix Corp.; a team of Collins Radio Co. and Aeronutronic Division of Ford Motor Co.; Hughes Aircraft Co.; a team of International Telephone and Telegraph Corp. and General Electric Co.; Philco Corp.; Radio Corp. of America, and a team of Western Electric Co., Inc., and Bell Telephone Laboratories, Inc.

Relay bidders conference, held at Goddard Space Flight Center in January, was attended by representatives of 41 firms. NASA plans to award the contract to build the lightweight satellite in time for launch in May, 1962.

vided them with the opportunity to present their case.

Connally and Assistant Secretary for Navy Research and Development James H. Wakelin, Jr., told the committee the Navy has a vital interest in space systems for weather, communications, navigation, geodesy, sea surveillance, space surveillance and space defense systems. This includes proposals for submarine, ship and water launch of solid-fuel space rockets.

Stahr and Lt. Gen. Arthur G. Trudeau, director of Army research and development, said the Army has space capabilities and resources in all seven of its technical services and has a definite interest in the fields of communications, mapping and geodesy, space surveillance and meteorology.

In addition, they said the Army Chemical Corps is working on the sterilization of space probes, the Transportation Corps has the experience and background to develop vehicles ranging from barges to haul massive boosters on the ocean to studying vehicles capable of operating on the lunar surface, and the Medical Service is doing biological research on the effects of ionization.

Gen. Trudeau was least successful in attempting to hide disappointment with the directive. In response to a question as to why it was drafted as it was, he replied: "We read every day of these great civilian minds that are coming in, and as a simple military man I accept these profound decisions as having been made with great wisdom." He later issued a public apology for the statement.

Rep. James Fulton (R.-Pa.) suggested to Gen. Trudeau that perhaps the reason the Air Force wanted to do all the space development work is that in time there will be no place in the air for USAF personnel when manned aircraft become obsolete and that if there is no requirement for manned spacecraft, Air Force personnel may be trying to find a place for themselves.

To this, Gen. Trudeau replied: "That's why we must be big-hearted and accept the directive. We would hate to have them known as the silent silo sitters of the Seventies."

USAF Stresses Small War Aims, Cooperation With Space Agency

Washington—Changing emphasis in Air Force policy that gives more attention to strengthening limited war capabilities and to meeting Army and Navy support needs was indicated by USAF's top civilian and military commanders during the House Armed Services defense posture hearings last week.

Secretary Eugene M. Zuckert and Chief of Staff Gen. Thomas D. White also emphasized the "close and harmonious" relationship with the National Aeronautics and Space Administration at both the policy and working levels and the need for continued coordination and cooperation with NASA because of USAF's recently increased military space responsibilities.

Zuckert told the committee, headed by Rep. Carl Vinson (D.-Ga.), that some changes being forced upon the U. S. by advancing technology have not been wholly mastered. New problems have come with the changes and new approaches with renewed efforts are called for to solve them, he said.

"The forces in being and planned," Zuckert said, "must be prepared for the whole spectrum of war, and for the use of both conventional and nuclear weapons. We must provide transport mobility for the Army as well as tactical firepower to support ground operations. We must protect the ground forces against enemy air power and provide air striking power to isolate enemy forces by interdiction of support."

The need for transport capability has already been recognized by the President and the recent action taken to procure additional and new aircraft should improve USAF's ability to transport Army strategic forces to any point on the globe, Zuckert said.

"I am giving and will continue to give personal attention to the question of adequate airlift and will not hesitate to recommend further improvement and expansion if that is indicated," he said. The adequacy of the airlift capability, the sufficiency of tactical forces and capabilities of air defense and strategic deterrent forces are all subjects of specific as well as continuing studies within the Air Force and Defense Department, he said.

Zuckert also told the committee:

• **"Tactical Air Command** and the whole complex of interdependent types of forces—ground, air and amphibious—are a matter of primary concern" to him and to Defense Secretary Robert McNamara. Of particular significance, Zuckert said, is development of integrated plans and training programs between the Strategic Air Command and Tactical Air Command.

• **To improve tactical air support** for Army, the Air Force has proposed a new tactical fighter of unique capabilities and is working closely with the other services on this project. Gen. White added that the fighter will be able to operate from very short, relatively unprepared air strips with a minimum of ground support. They apparently were referring to the STOL fighter-bomber (FTX) now under consideration.

• **"Following the missiles** now programed, the next indicated major step-up in SAC's power is the B-70. If we expect to attain this new capability in five years we should have a funding commitment no later than the next fiscal year." This statement appeared to confirm reports that the B-70 program is again in danger of being cut back.

• **"The principle of defense** against a ballistic missile is exactly the same as any other air defense—the destruction as far from our borders as possible. The primary air defense requirement, therefore, is for a means of detecting, intercepting and destroying an intercontinental ballistic missile close to lift-off.

• **"A large part of Air Force research** and development work is necessarily devoted to space requirements. Almost every product of Air Force work to meet defense requirements in space is applicable to the developmental work of NASA and vice versa . . . Air Force objectives are different, but they are not inconsistent with nor incompatible with the statutorily defined national policies underlying the NASA program."

Zuckert said that other witnesses would explain "how and why the Air Force must press on with its own broad program of space-oriented work, and why, for defense reasons, NASA must succeed as promptly as possible in big booster development." Last year the Air Force and Defense representatives said there was no military requirement for boosters bigger than those now available but that there might be a requirement in the future.

• **Nuclear propulsion** for aerospace vehicles is "not just a scientific and engineering possibility. It is a military inevitability."

Gen. White presented the committee with a strong argument for continuation of manned aircraft systems to perform vital war functions which require on-the-spot, trained human judgment.

One significant improvement in the current and near term capabilities for limited conflict has been the advent of the F-105 tactical fighter, he said. "The F-105 will permit us to do a better job for the Army than we have ever been able to do before—in close support of ground battle, as well as in other phases of the tactical mission."

For flexibility, Gen. White said, the Air Force needs a system that can search out and destroy mobile targets, as well as fixed or rapidly developing targets whose positions are uncertain or unknown until observed. He said the B-70 was specifically conceived and designed to fulfill these tasks.

White House Reviews NASA Proposals

By Edward H. Kolcum

Washington—White House review of proposed changes in the Fiscal 1962 space program was conducted last week to provide a space agency total for the Kennedy Administration budget, but detailed changes are not expected to be completed until next month.

The budget and proposed changes were discussed last week by National Aeronautics and Space Administration Administrator James E. Webb and Deputy Administrator Dr. Hugh L. Dryden with President Kennedy and Budget Director David E. Bell. Meanwhile, NASA concluded preliminary testimony before the House Committee on Science and Astronautics on Fiscal 1962 authorizations, basing its discussion on the Eisenhower Administration budget and programs. The agency expects to be recalled when detailed changes are approved by President Kennedy.

Committee hearings last week were highlighted by charges that NASA is not making full use of existing life sciences research facilities and is developing unnecessary in-house capabilities.

The charges by Rep. Emilio Q. Daddario (D.-Conn.) enlarged on an earlier report he made to Chairman Overton Brooks (D.-La.) essentially urging that NASA be blocked from further expansion of its life sciences program until a new national program is established (AW Mar. 6, p. 27).

Rep. Brooks, who refused to permit the Daddario report to be printed with committee funds, obviously disagrees with this position. He congratulated NASA Life Sciences Director Clark Randt on his presentation, and said the findings in the report represent views only of Rep. Daddario. The committee expects to take no action on them, according to Rep. Brooks.

Daddario said he cannot subscribe to a need for NASA to develop a capability that already exists in other areas, and he questioned Dr. Randt on the need for a $700,000 animal enclosure when adequate vivariums exist at Holloman AFB and the School of Aviation Medicine, both Air Force facilities.

Dr. Randt said the request for a new vivarium has been withdrawn, and existing facilities at Ames Research Center will be modified to house research animals. He added that a vivarium is needed so that NASA can attract the highest quality scientists to provide leadership for its life sciences programs because "they need their own subjects for research work."

The broad flight and ground-based life sciences research projects outlined by Dr. Randt in the areas of radiation, weightlessness and infrared spectroscopy obviously were aimed at justifying NASA's programs on the basis that they are not being done by any other agency. Flight programs planned include:

- **Series of extended orbital** flights in modified Mercury capsules (AW Mar. 6, p. 27), some containing two monkeys and a chimpanzee, to study weightlessness. Sequential primate test objectives would be studies of performance of complicated tasks; electrical measure of brain activity to determine consciousness, anxiety and brain metabolism, and heart and circulation. Flights would range from one to 14 days. Fourth package would contain lower life forms such as fungi bacteria, viruses and eggs, and tissue culture to study fertilization, cell division, development, physiologic and genetic processes. Radiation monitoring and micrometeorite impact measurements will be included.
- **Spectroscopy,** to validate and use infrared for identifying organic life-supporting compounds. Three-part studies will be made first from low altitude directed toward earth vegetation, then from aircraft flying above 60,000 ft. directed toward planets and stars, and finally from earth-orbiting satellites.
- **Radiation studies,** including continued balloon-carrying mice experiments, continuation of the Nerv (nuclear emulsion recovery vehicle) launches, and probe and satellite experiments.

Applied biotechnology sections in NASA's life sciences program were justified by Dr. Randt as necessary to support the flight program and to provide technical support for manned space flight. NASA is developing sensors and criteria for determining requirements for integration of man with the spacecraft, Dr. Randt said, and the military services are providing data on stress tolerance limits, crew performance in isolation and confinement, and ground crew safety.

In explaining his agency's use of existing non-NASA capabilities, Dr. Randt said his office, which has $5 million to spend for research in Fiscal 1961, has received 191 proposals during the first eight months of the year. It has committed $3.5 million, 43% of which has been awarded to industry, 36% to universities, and 21% to other government agencies, principally to the Defense Department.

Rep. James G. Fulton (R.-Pa.) objected to the announced NASA-Atomic Energy Commission plan to award a single prime contract for the Rover nuclear rocket and suggested more competition in space component bidding. Both Rep. Fulton and Rep. Joseph Karth (D.-Minn.) told Maj. Gen. Don R. Ostrander, NASA launch vehicles director, they felt in view of the recent hearings on propulsion (AW Mar. 20, p. 50) that not enough is being done in solid propulsion.

Gen. Ostrander said he is not convinced that all statements made by contractors are correct, but also said he has recommended acceleration of solid-propellant booster program to determine whether capabilities expressed for large solids can be demonstrated.

NASA must decide whether economy, simplicity and reliability of large solids offset the lower specific impulse, Gen. Ostrander said.

Ira H. Abbott, advanced research director, told the committee NASA is continuing aeronautical research on supersonic transports, high cruise efficiency, off-design performance, flying qualities, and extension of research aircraft to higher speeds.

He said he does not believe the 4,000-mph., 50-mi. altitude design performance of the X-15 is the ultimate this research aircraft can attain.

GEM Competition

Washington—Design proposals for a 15-ton ground effect machine (GEM) are due May 1 in a competition Office of Naval Research is conducting for the Defense Department. Decision is expected July 1, and a limited number of vehicles will be ordered for evaluation.

The GEM is to replace amphibious landing craft and to be capable of crossing a beach and unloading further inland. It would be very similar to the Army's proposed Logistic-Over-the-Shore (LOTS) vehicle.

New Congo Airline

Communist-oriented Stanleyville regime in the Congo has established a new independent airline, Transport Aeriens Congolais, reputedly to break a "monopoly" held by Belgium's Sabena Airlines.

Organization of the new airline is interpreted in Moscow as a first step toward operation of supply flights from the Soviet Union to the Congo. According to Pravda, the Stanleyville government is now applying to African nations for rights to fly over their territories. Presumably, the new Congolese airline will be equipped with Russian-built Il-18 turboprop transports. Ghana Airways is now flying this aircraft on its African routes, and Guinea is showing an interest in purchasing a fleet **(see p. 48).**

East Germany to Curtail Aviation Industry

Geneva—Fate of the Type 152 four-engine medium-range jet transport, originally designed as the symbol of a resurging technology, was still being debated in East German politico-technological circles late last week following announcement of a drastic government retrenchment program that portends virtual abandonment of most of the nation's aviation projects.

Designed primarily for prestige and propaganda and plagued from the start by technical problems and design team defections, the 152 is the most significant of the projects caught up in East Germany's reshuffling of industry in its effort to overcome increasing labor and economic ills. Scope, if not the intent, of the new directive apparently was as unclear in the east last week as it was in the west. Major speculation naturally surrounded Type 152.

A spokesman for the East German State Planning Commission, while declining comment on all other questions, said that details of the new plan were still under discussion and might be resolved within a few days.

No Decision

An official of Deutsche Lufthansa, East Germany's state-owned airline, said "no decision" had been reached as to whether the carrier will be equipped with the Type 152 as planned.

Spokesmen for Technocommerz, GmbH, the East German aircraft sales organization, in answering a query as to the scope of the plan, said only that it was their understanding that the 7,260-lb.-thrust Pirna O14 A-1 turbojet engine designed to power the 152 would remain in production.

Dr. Brunolf Baade, original designer of the transport for Veb Flugzeugwerke in Dresden and now the firm's director of research, was unavailable for comment.

The Pirna O14 also was to have powered the 152's smaller sister, the twin-jet Type 155, but the latter development apparently was canceled sometime before the recent industry readjustment plan was made public by Bruno Leuschner, the State Planning Commission's head. Letter of intent with English Electric Co., Ltd., for constant-frequency a.c. generating systems for use on production models of the Type 155 was canceled by the East Germans approximately six weeks ago.

Order for three sets of the system for integration into ground test rigs (AW Mar. 14, 1960, p. 34) already had been fulfilled by English Electric. The letter of intent called for an unspecified number of sets for 155 production models.

Comments as to the extent the "people's economic plan for 1961" will have on the aviation industry as a whole were left perhaps deliberately vague when the new program was outlined by Leuschner at the 12th plenary session of the East German Communist Party's Central Committee. It was evident, however, that most of the industry would be diverted to new roles.

After detailing the need for more basic goods and tools to bolster a sagging economy and the "enormous sums of money" that would be required to erect new facilities to produce them, Leuschner said:

"This is the reason why the Politburo has decided to use the capacity of our aircraft industry to bridge the gap. We are employing thousands of highly qualified and efficient engineers, skilled technicians and experts in this branch of industry which is using modern equipment and highly productive machines.

"In these large factories, it will be possible to produce economically all kinds of hydraulic apparatus, certain special machines and other items for the building industry, mechanical equipment and automatic devices for internal transport, chemical equipment and much more.

"The existing metal-working installations will be utilized to press parts for transport vehicle production and light metal-working construction for the building industry. All this should enable us to make rapid strides forward in the realization of the set goal."

If the 152 is allowed to live as a project for a while longer, it appears that its life-span will encompass only a few production aircraft for delivery to Deutsche Lufthansa as a flag-waving measure. Export sales campaign by Technocommerz in the west as well as the east apparently has been scrapped.

Leuschner's belt-tightening and redirected plan, which included admonitions to trade only within the eastern bloc whenever possible, followed closely on the heels of the Leipzig technical fair (AW Mar. 20, p. 43), where the value of both exports and imports were highly praised.

At the fair, Technocommerz Director Roland Schumann told AVIATION WEEK that the second prototype of the 152 was currently completing its flight test program at Veb Flugzeugwerke and that production "is expected to go ahead as originally planned" (AW Mar. 20, p. 43).

Export Models

Plans, as originally announced, called for the first export models to be available by the middle of 1961, but Deutsche Lufthansa officials at Leipzig said they expected deliveries only by late 1962 or early 1963.

The program itself, representing East Germany's attempt to strike out on its own after building approximately 100 Soviet Il-14 piston-engine transports under license between 1956 and 1959, has been plagued since its beginning by technical and personnel problems.

First prototype crashed in the spring of 1959 and shortly afterward, Baade was boosted from head of the design team to director of research at Flugzeugwerke. His successor, Fritz Freytag, defected last October and is scheduled to go to work for Weser Flugzeugbau, a leading West German aviation firm, early next month. Man-

Do.27 Retrofitted With Astazou Turboprop

Dornier Do.27 retrofitted with a Turbomeca Astazou turboprop is shown at Pau, France, near Turbomeca's plant. New 440-hp. engine (plus 66 lb. residual thrust) replaces 275-hp. Lycoming piston engine. Propeller is a Ratier-Figeac. Program is being financed by Turbomeca and carried out by SFERMA, a subsidiary of Sud Aviation. Flight tests have started (AW Mar. 13, p. 308) but no performance data has been released.

fred Gerlach, another associate on the project, was sentenced to life imprisonment last year on charges of spying for the west.

The new plan will further divide and break up the top design and technical talent that East Germany had depended on to provide it with a healthy aviation industry within the scope of its assigned contribution to the Soviet bloc.

Non-Aviation Activities

Many of the engineers undoubtedly will remain at their present posts—but designing automobile bodies and agricultural machinery rather than aircraft. Others will be farmed out to factories where added technical skills are needed to improve production methods and efficiency.

Over-all, West German sources estimate East Germany's present aviation labor force at between 25,000 and 27,000—as opposed to the 20,000 for the healthy West German industry which is turning to on a number of projects.

The figure also probably includes that segment of the East German electronics industry which has been closely allied with the airframe and engine firms designing and producing instrumentation for the Types 152 and 155.

Projects mentioned by Leuschner that the avionics engineers and facilities may now be called upon to produce include television sets, electric washing machines and automated equipment and controls which will be scheduled for factory use.

Emphasis Shift

The shift in emphasis, Leuschner indicated, is necessary in order to combat an increasing shortage of consumer goods and housing and to bolster an already strained labor force.

Admitting that East Germany is faced with "grave problems" in its efforts to meet its goals under the present seven-year plan now in its second year and to satisfy consumer demands, Leuschner said the state plans to increase 1961 machine tool production by 110% over that of 1960.

Other items which have been singled out for production boosts ranged in scope from gas heaters to earth-moving equipment. The East German share of the Soviet-bloc aviation consortium has not been the best—short-range transports and sailplanes—and western observers have speculated for some time as to whether the industry could survive (AW Apr. 11, 1960, p. 122). Feeling, however, had been that it would be maintained at almost any cost as an instrument of national policy in the fields of prestige as well as propaganda.

S-61D for NATO Envisaged

Sikorsky S-61D helicopter being proposed to NATO countries is shown here in artist's conception with markings of West German air force. Clamshell doors and rear loading are a new characteristic of the twin-turbine design; most of the other features have already been tested in the U. S. Navy's HSS-2 anti-submarine warfare helicopter, another S-61 variant (AW Jan. 16 p. 52). Sikorsky is in vigorous competition with Boeing-Vertol Division and Sud Aviation for a West German order (AW Jan. 9 p. 37), with Vertol's position recently strengthened as a result of the choice of the 107 Model II by the U. S. Marine Corps and a production order for the HC-1B Chinook for the Army.

Welsh Nominated Space Council Aide

Washington—Edward C. Welsh, legislative assistant to Sen. Stuart Symington (D.-Mo.) since 1953, was named executive secretary of the National Aeronautics and Space Council last week.

Nomination of Welsh was President Kennedy's first move toward building a permanent staff to advise him on space and mediate disputes between government agencies over roles and missions. The council is a statutory body in the 1958 Space Act, but it met only a few times in 1959 and not at all during the past year. It has never had a permanent staff and has had only part-time secretaries.

Legislation is now pending to permit Vice President Lyndon Johnson to head the council rather than President Kennedy, as is now required in the Space Act.

The Senate space committee approved Welsh's nomination after a brief hearing in which he was asked no questions and did not even read a prepared statement on his background and qualifications. Sen. Symington, a committee member, praised Welsh highly and endorsed his nomination.

Welsh, whose salary will be $20,000, can hire three top staff assistants at salaries up to $19,000 each. There is no statutory limit to the total size of the staff.

Welsh, 51, graduated from Lafayette College and did graduate work at Tufts College and Ohio State University. He taught economics 12 years before becoming a government economist in 1937. Since he joined Sen. Symington's staff, he has been staff director of the Senate airpower subcommittee and staff director of the presidential defense reorganization committee.

Other appointments made last week:

- **Dr. Lloyd A. Wood,** former chief of research grants and contracts and former scientist for advanced technology in the National Aeronautics and Space Administration, to be director of the Air Force Office of Scientific Research's Physical Sciences Division.
- **John W. Dixon,** former assistant to the vice president for planning of General Dynamics' Convair Division, to be systems planning consultant in the office of Assistant Defense Secretary Charles J. Hitch.
- **Robert T. Murphy,** appointed by President Kennedy vice chairman of the Civil Aeronautics Board. He replaces Chan Gurney, who remains on the board.

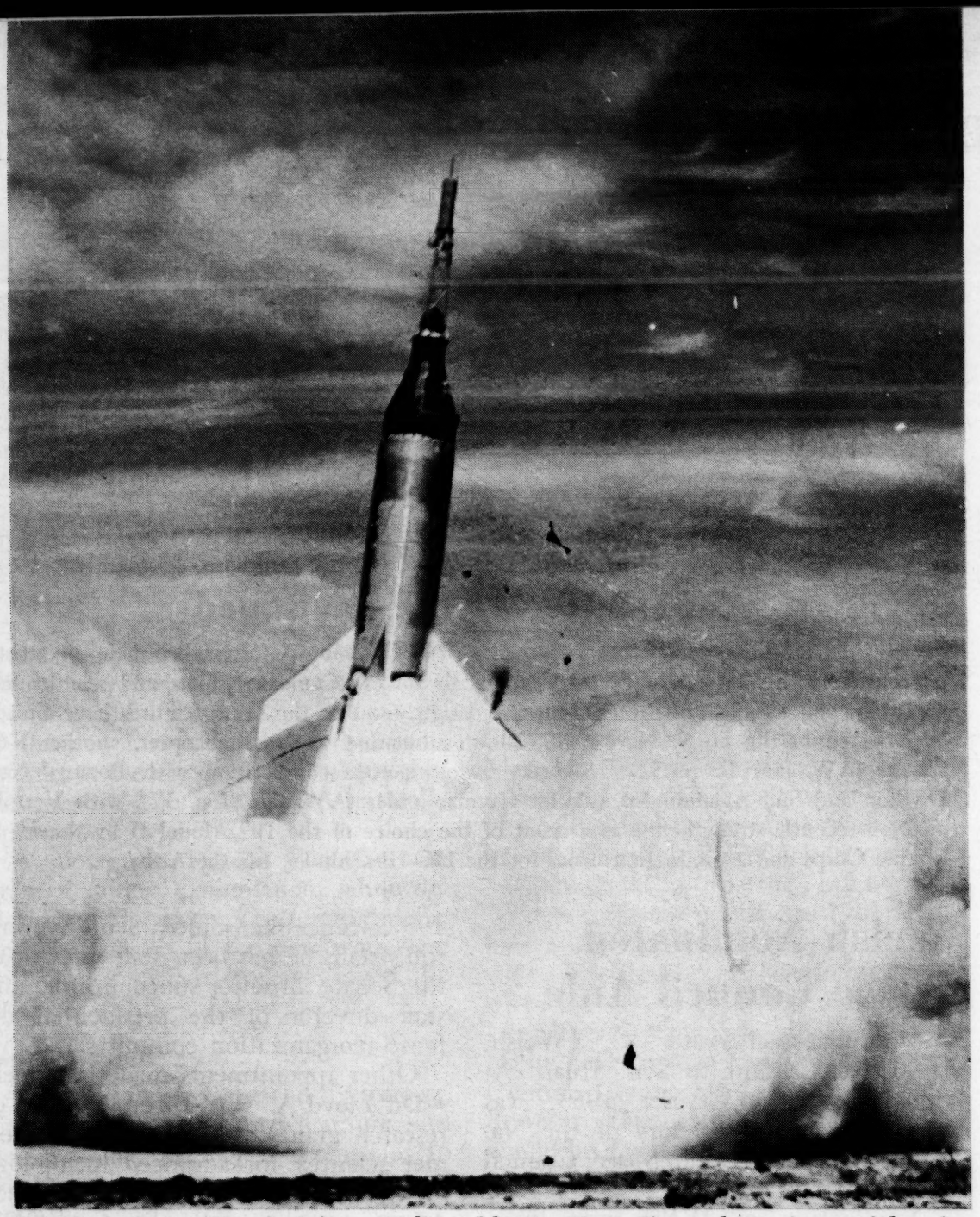
German T-38 Interest

German air force team is scheduled to visit Edwards AFB, Calif., this week to evaluate the supersonic Northrop T-38 trainer as a possible eventual replacement for the Lockheed T-33.

U. S. Air Force T-38, due to be displayed at the Paris air show in late May, also probably will be flown to West Germany before and after the show for further trials.

Final decision on a new trainer may be made by early June.

The T-38 was recently accepted by the Air Training Command at formal ceremonies conducted at Randolph AFB, Tex.



LITTLE JOE VI is launched from Wallops Island with six live and two inert solid rocket motors. Malfunction in the sequencer prevented full test of capsule and escape system under high dynamic loads. Capsule was retrieved by tug and returned by helicopter.

Little Joe VII Flight Scheduled by NASA

Washington—Seventh Little Joe launch will be necessary in the Project Mercury flight-test program because a malfunction in the sequencer prevented qualification of the production capsule under maximum dynamic pressures in the Little Joe VI test, Mar. 18 at Wallops Island, Va.

Successful test of the McDonnell Aircraft Corp. capsule and its escape system under maximum dynamic pressure and successful Redstone booster qualification test are considered essential before manned ballistic flight can be attempted. Little Joe VI was the second unsuccessful attempt to test structural integrity of the capsule and operation of the escape system under loads of 1,000 psi. and 20g, which could occur during an actual abort at low altitude.

Previous attempt was made last November (AW Nov. 14, p. 34) when an electrical circuit failed and the booster and capsule did not separate. Booster performance and separation were formal on the Little Joe VI launch. Another Redstone booster flight (AW Mar. 20, p. 27) was scheduled late last week, carrying a dummy capsule.

Although four months elapsed between Little Joe V and VI, National Aeronautics and Space Administration has another Little Joe booster which can be assembled for the seventh launch within two weeks.

Little Joe VI fell short of its goal when the escape rocket fired about 10 sec. early and the three-parachute recovery system deployed simultaneously—faults traced to the operation of the sequencer.

The parachute pack, containing drogue, main recovery and reserve recovery parachutes, deployed near the 40,000-ft. apogee, and the capsule was carried 18 mi. to sea, about 12 mi. farther than planned.

Drogue chute is supposed to deploy near this altitude, and the main parachute is to open at 10,000 ft. The reserve parachute is programed to deploy only when the main recovery chute fails.

One of the exterior hull shingles was dented during the flight, probably by the retrorocket package when it was jettisoned.

NASA said, however, that the capsule was in excellent structural condition when it was picked up 71 min. after launch by a Navy tug.

Helicopter recovery could not be made from sea because the parachute system did not disengage on water impact, and the 63-ft. ringsail chutes covered the connections used for an air pickup.

Bell's All-weather Automatic Landing System—symbolized.

CLEARED TO LAND, WEATHER OR NOT

Today's increasing air traffic demands faster and safer all-weather operation at every airport.

Bell brings this goal one important step closer with its All-Weather Automatic Landing System (ALS) which can fly two airplanes to touchdown every minute, even when visibility is absolutely zero.

The Bell ALS takes over when the pilot brings his plane through the electronic "window in the sky" and guides it to a safe and sure landing.

The system has been flight-proved in more than 4,000 landings with all types of aircraft—small private planes as well as airliners from the DC-3 and DC-7 to the huge Boeing 707 jet. It now is being evaluated at FAA's National Aviation Experimental Center, Atlantic City, N. J.

Unlike other automatic landing systems, the Bell ALS is ground-based so a ground observer monitors every approach and landing. It can operate either fully automatically or under pilot control.

Military versions of the ALS have been ordered by the Air Force. The Navy has selected it for installation aboard the nuclear-powered aircraft carrier USS Enterprise as well as for its other large carriers.

The Bell ALS is but one among many contributions which Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

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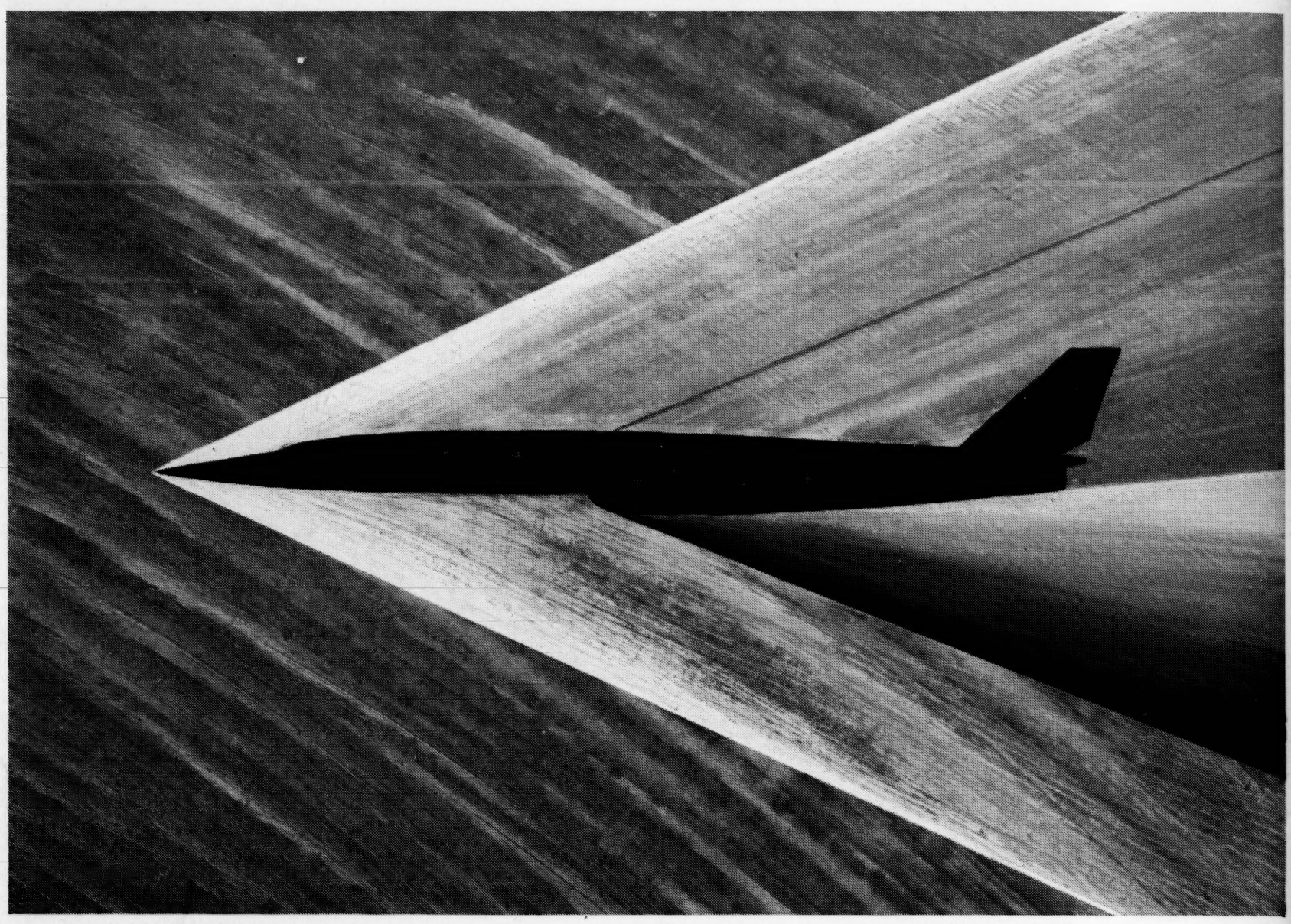


Mach 3 Technology

Designing a plane to ride triple-sonic shock waves like a surfboard

For years manned aircraft have been imprisoned in their own V-shaped shock waves which were created when traveling at high speeds. These waves caused a tremendous increase in drag, and a consequent heavy penalty had to be paid in fuel consumption, limiting the range of supersonic flight.

This was the problem facing the engineers at the Los Angeles Division of North American Aviation as they designed the Mach 3 B-70 Valkyrie bomber for the Air Force. The answer lay in an entirely new principle of aerodynamic science which had been discovered by the former National Advisory Committee for Aeronautics. This principle was that, properly designed, a triple-sonic aircraft could actually ride its own air patterns somewhat like a surf-rider on the crest of a wave.

North American engineers set out to design a wing and undersurface which would make use of this aerodynamic principle. The result was a delta wing shaped in the V which would be made by air waves when flying at Mach 3 speeds. The design was highly practical. With this new design advance, there now exists a means for manned aircraft to not only reach triple-sonic dash speeds, but to cruise for intercontinental distances at them.

Advanced design achievements like this will help sustain America's leadership in aircraft by making possible the Mach 3 B-70 and future commercial aircraft.

Builders of the B-70 Valkyrie

THE LOS ANGELES DIVISION OF **NORTH AMERICAN AVIATION, INC.**

First Ion Flight Test Advanced Six Months

Washington—First flight test of an electric space propulsion system has been advanced six months and is now scheduled for October, 1962, under a National Aeronautics and Space Administration decision to increase funding for a Hughes Aircraft Co. cesium-fueled ion engine.

NASA has added $321,200 to an earlier $490,000 Hughes contract and has told Hughes to proceed with development and construction of flyable 0.002-lb. thrust engines which will be clustered to produce 0.01-lb. thrust. Original Hughes contract (AW Oct. 31, p. 28) was for a single-chamber 0.01-lb. thrust laboratory engine, which would have been completed and laboratory tested by September.

Acceleration of the contract is to make a flyable engine ready for delivery in a year and calls for first test flight the following October.

Hughes Aircraft will continue development of the single chamber 0.01-lb. thrust engine.

At least four tests will be flown at three-month intervals as Scout payloads. Scout can provide about an hour of flight above 250 mi., and it is capable of carrying two different electric engine types on the same flight.

It is likely that the mercury vapor ion accelerator developed by NASA's Lewis Research Center (AW Mar. 20, p. 19) and the Hughes engine will be tested on the same flight.

These battery-powered engines are first-generation developments leading to nuclear-powered electric engines developing 0.1 lb. thrust and specific impulses of 4,000-6,000 sec., and having operating lifetimes of a year or more.

Test objectives of the first flights will be to:

- **Measure beam neutralization,** considered the most critical ion engine design problem because the engine must exhaust a neutral beam or thrust will be dissipated by the nozzle attraction.
- **Study clustering techniques,** since one of the possibilities for the operational electric propulsion system to be powered by the Snap 8 reactor in a 1965 Centaur-boosted flight is a cluster of 10 engines, each with a thrust of 0.01 lb.

The Scout-boosted engines will be powered by two-volt zinc cadmium batteries.

NASA's Marshall Space Flight Center, which is administering the contract, will request study contract proposals soon, covering recommendations on payload recovery. Recovery may be necessary because telemetry signals cannot be transmitted through an ion beam.

NASA plans to measure thrust level of the ion engines by measuring the force the engines can exert in de-spinning the Scout fourth stage. This technique involves a theory which was developed by Dr. David G. Elliott of California Institute of Technology's Jet Propulsion Laboratory (AW Nov. 21, p. 63).

Boeing Earnings Rise Due to 707 Program

New York—Boeing Airplane Co. 1960 net earnings of $24,462,100—almost double the $12,743,402 earned in 1959—were attributed by William M. Allen, president, to "favorable developments on the commercial 707-720 jet transport programs."

Sales for 1960 were $1,554,572,612, a bit lower than the 1959 sales figure of $1,648,802,758. Earnings per share for 1960 were $3.07, compared with $1.60 a share for 1959.

After allowing for the uncertainties inherent in both military and civil aircraft programs, Allen said that 1961 sales and earnings should improve over 1960 levels.

His prediction was based on current programs and schedules.

Boeing's backlog of unfilled orders was $2.139 billion at the end of 1960. The backlog included $732,950,000 in orders for military aircraft, $612,200,000 for missile and space program orders and $793,850,000 for commercial orders.

About $400-million additional in military orders is being negotiated.

Other aircraft companies reporting 1960 sales and earnings are the following:

- **Martin Co.,** which reported sales of $651,227,929, a 24% gain over 1959 sales of $523,707,022. Missiles, electronics and related equipment accounted for 92% of total sales. Net earnings for 1960 were $16,854,540 or $5.43 a share. This represents a 26% increase over 1959 net earnings of $13,336,981 or $4.34 a share. The primary reason for the gain in earnings was the growth in sales. Martin's backlog of unfilled orders is at a record level, exceeding $1 billion.
- **Republic Aviation Corp.,** which reported net earnings of $4,703,096 or $3.29 a share on sales of $215,273,844, compared with 1959 earnings of $3,413,107 or $2.37 a share on sales of $198,065,976. Backlog of orders was $637 million at the beginning of this year; it was $511 million a year earlier. Acceleration of F-105D fighter-bomber deliveries in 1961 and 1962 is expected to produce increases in sales and earnings over 1960.

News Digest

Venezuelan Airlines LAV and Avensa are being merged to form a single flag carrier called Viasa—Venesolana Internacional de Aviacion. The new carrier will operate Convair 880-M turbojet transports on its routes to Miami and New Orleans. Civil Aeronautics Board has been asked to transfer foreign air carrier permits of the two carriers to Viasa.

International Air Transport Assn. airlines will operate IFR, regardless of weather, in controlled airspace over Europe, the Middle East and parts of Africa beginning Apr. 1. IATA said it believes all aircraft in high density traffic areas should be under positive traffic control at all times.

X-15 and mother ship were threatened last week by fire in right forward truck of B-52s landing gear. When B-52 returned to base because of telemetry malfunction in X-15, drogue chute failed on landing and fully loaded condition of X-15 caused excessive braking. Fire, which occurred at completion of landing roll-out, was confined to wheel truck.

Lester P. Arnold, 66, pilot of one of three Army aircraft that covered 27,000 mi. in 175 days during a 1924 flight around the world, died last week. He was an Eastern Air Lines vice president until last July.

Maj. Gen. Victor E. Bertrandias, 66, pioneer in organizing the Air Force flight safety program, died last week. He was the first USAF director of flight safety research before his retirement in 1955, a Douglas Aircraft Co. vice president while out of the Air Force before and after World War II, and a consultant to several companies after he retired.

General Telephone and Electronics has developed a special echo suppressor which can eliminate the bothersome echo effects in telephone transmission over the 45,000-mi. path to and from stationary telecommunications satellites.

Charles J. Donlan, associate director of National Aeronautics and Space Administration's Space Task Group for technical development, becomes associate director of NASA's Langley Research Center Apr. 1.

J. E. Rheim resigned as president, general manager and director of Rohr Aircraft Corp. last week. Rheim's resignation followed a long illness.

Liberal U.S. Foreign Air Policy Indicated

Eagle Airways Bahamas-Florida route is approved, highlighting signs of more generous philosophy.

By L. L. Doty

Washington—President Kennedy's approval of a foreign air carrier permit giving Eagle Airways a Bahamas-Florida route underscores increasing indications that a more liberal philosophy has been adopted by the new Administration for international air route negotiations.

Decision to award the new route to Eagle was reached by the Civil Aeronautics Board Apr. 28, 1960, and the order was promptly sent to the White House for action. It was the only foreign air carrier permit awaiting a presidential decision that was not acted upon by President Eisenhower before his term expired. President Kennedy signed the permit Mar. 13, less than two months after his inauguration, on the basis of the Board's original recommendation to President Eisenhower.

In terms of traffic volume or in its relation to over-all international route structures, the route in question is relatively unimportant. Real significance of the Kennedy action, however, lies in the question of whether the economic welfare of U. S. carriers or the public interest should be subordinated to foreign policy considerations in decisions on air routes for foreign flag carriers.

At stake in the Eagle Airways case is the economic impact two British carriers will have on a single U. S. carrier, Mackey Airlines, which is confined in its scheduled operation to routes between terminal points in southern Florida, the Bahamas and Havana. Until the foreign air carrier permit was granted to Eagle Airways, Mackey was operating the route in competition with Bahamas Airways, an authorized British carrier.

Mackey has estimated that, if it were faced with direct competition from two British carriers, diversionary losses would amount to some 40% of the available traffic. The Board, in its order, admitted that there will be a "diversionary strain until traffic losses will be offset by traffic growth," and estimated the initial loss in traffic to Mackey would be about 50%. It added, however, that:

"The public interest in the development of an air transportation system properly adapted to the present and future needs of our nation lies with the avoidance of conduct which, by example, could invite other governments to scale down the rights of our foreign flag carriers to fit the generally more modest competitive abilities of their own aviation enterprises."

The Board emphasized that it would recommend the renunciation of a bilateral agreement which created a disastrous effect upon a U. S. carrier but found that the designation of a second British carrier on the Florida-Bahamas route, while having a "significant" effect on Mackey, would not bring about "crippling" or "fatal" consequences. Mackey agrees that it is determined to survive, but emphasizes that the competitive impact will be serious.

The Board is empowered by the Federal Aviation Act to grant an air carrier permit to a foreign flag airline if it finds that the airline is "fit, willing and able" to serve the route and that "such transportation will be in the public interest." It is also obligated to exercise its powers in conformance with any "obligations assumed by the United States in a treaty, convention or agreement that may be in force . . ."

It found that Eagle was fit, willing and able and that its operation will be in the public interest, since its effect on Mackey would not be "disastrous." Its action was in accordance with the bilateral agreement with the United Kingdom, the Bermuda agreement, which provides for multiple designation of carriers on routes served reciprocally by each country.

Mackey presented what was considered a strong case in its arguments before the Board that the public interest would be adversely affected by the granting of the Bahamas route to a second British flag carrier.

Mackey felt that Northwest Airlines offered strong arguments against the grant of a Tokyo stop to British Overseas Airways Corp. in 1959 proceedings and studied Northwest's tactics carefully in hopes of closing any loopholes the Board might use to break down public interest arguments. The issue of public interest is the principal weapon U. S. carriers have in defending routes against increased foreign competition, and the Board carries a legal right to apply the issue in making its decision. The President also had to consider the public interest question in reaching his decision.

The issue of how far the U. S. should go in permitting economic damage to U. S. carriers before foreign relations are placed in jeopardy remains a controversial point that has been argued in a number of previous cases brought before the Board. Although the Kennedy Administration, by approving the Eagle permit, has tacitly endorsed the policy that economic considerations take a back seat to foreign policy, vacillation on the subject through the past decade highlights the need for a standard policy to serve as a guide in future foreign route cases.

As yet, the new Board, headed by Chairman Alan Boyd, has not had a full opportunity to express its views on the subject through a decision on a route case, but no previous Board has ever denied an application to a foreign flag carrier for a foreign air carrier permit on grounds that the public interest would be affected.

If there is a basic doctrine on the subject, it is incorporated in a decision handed down in the Montreal-New York Service Case. Known generally as the Trans-Canada Doctrine, this decision says: "In considering the application of a foreign air carrier for a permit authorizing service into this country, the Board cannot confine itself to the economic effect on domestic carriers or on the local transportation needs of American citizens . . . Since broad questions of international relations and the over-all foreign policy of the United States are matters which are properly within the purview of the chief executive and the Department of State, we believe that recommendations and conclusions of the latter should be given great weight in determining the public interest in connection with the grant of routes to foreign air carriers."

In concurring with a decision granted a Tokyo stop to British Overseas Airways Corp. in May, 1959, former Board member Louis J. Hector went a step further and charged the public interest issue in the granting of foreign air carrier permits is a "fiction" and that

only the terms of the bilateral agreement are the legal factors behind foreign route decisions.

Hector said that Northwest had proved a public interest case and added that "it is clear to me that were it not for the bilateral, Tokyo would not be granted to BOAC . . ." He said that Tokyo was given to BOAC because the U. S. had entered into a solemn and binding agreement and that it was unfair to U. S. carriers to let them go on believing that a route case can be won on the issue of public interest.

In the same case, former Board Chairman James Durfee held that it is the role of the Board to evaluate economic considerations, the responsibility of the State Department to advise the President on diplomatic and foreign relations matters and the duty of the President to decide "whether the U. S. should honor its bilateral obligations, refuse to honor them, denounce the bilateral, or take some other course of action."

The fact remains, however, that lines of authority in interpreting the need for routes or in the granting of air carrier permits have not been sharply drawn and that any final decision is often subject to the differing opinions of a large number of government officials.

In its opinion in the Eagle Airways case, the Board emphasized that its decision was based on the questions of whether it should grant the route to a second British carrier under the terms of the Bermuda agreement or shield Mackey from the economic effects of the new competition. It then noted that ". . . while the economic impact of the agreed competition upon American carriers (in bilateral agreements) is a factor to be counted in reckoning the public interest, the matter must be viewed in the larger setting of the entire route exchange."

CAB found that the public interest would not be adversely affected by the addition of Eagle to the route and then concluded that "the Bermuda agreement is an important instrument by virtue of which our flag carriers have been assisted in forging a worldwide route system via British points." It added that the agreement has been recognized as one of the "wise investments in the future of American commercial aviation" and was designed with the understanding by both parties that the two services would "result in some diversion from existing routes."

Eagle was granted a route between the Bahamas, the intermediate point Havana and the coterminals of Miami, Palm Beach, Fort Lauderdale and Tampa. In an earlier phase of the case, the Board granted the carrier a Miami-Havana-Nassau route.

CAB Ruling to Sharpen Competition Between Airline, Other Credit Plans

Washington—Competition between the airlines' Universal Air Travel Plan and general purpose credit card systems will increase sharply this year in the wake of Civil Aeronautics Board decision clearing the way for a broad expansion of UATP.

CAB made it clear last week that the carriers can use general purpose plans. Board approval of a UATP expansion will permit the airlines to make their system competitive with these plans, and Air Traffic Conference members are intensifying their sales campaigning to broaden UATP and provide more than a million current card holders with personal credit from hotels, motels, car rental agencies, restaurants, communications and other business services.

The airlines claim that more than 1,600 vendors have agreed to participate in the plan during the past few months, and the Board's approval can be expected to accelerate this growth.

Most carriers object to the use of such credit plans as Diners Club and the Hilton Carte Blanche for air transportation, and they moved last year to expand their own credit plan to meet the competition. The Board did not approve the expansion plan until last week. The Board still has the general airline credit situation under study in a formal investigation of all the plans.

Granting approval of the expanded plan, CAB noted that it had at first considered rejecting the idea last year on grounds that it might give the airlines a monopolistic position in air travel, but finally decided to approve it after issuing recent orders rejecting resolutions by ATC and the International Air Transport Assn. which were designed to restrict the use of outside credit plans. The possibility of airline monopoly with UATP was avoided by permitting competition from outside credit card companies, the Board said.

Major contenders among the outside companies bidding for a greater share of the air travel credit business are the Diners Club, Inc., American Express Co., and the Hilton Credit Corp., which do not require a deposit by the card holder but levy an average 7% commission on the vendor whenever the card is used. Diners Club officials have estimated that charges collected from smaller airlines, such as Northeast and Western Air Lines, have totaled about $4 million annually and that this figure could exceed $30 million in the future.

Under the UATP plan, honored by 118 domestic and foreign flag international airlines, company or individual card holders are required to make a $425 deposit, and no commission is paid when the card is used. In 1959, these deposits amounted to more than $10 million for American Airlines and nearly $7 million for United Air Lines.

Billings for the added services under the expanded plan will be made directly to the user, freeing both the Air Traffic Conference and the individual airline from any responsibility for bad debts.

While the Board's approval of UATP expansion is regarded by most airlines as a distinct victory which will permit them to retain much of the present credit business while gaining more in the future, many who favor competing plans contend that the advantage may be only temporary because of the pending Passenger Credit Plans Investigation. The primary purpose of this CAB case, investigating all credit plans, is to determine whether or not airlines should charge card holders for the necessary accounting expenses involved in the use of credit plans for air travel. If the Board decides that such charges are required, UATP would lose one of its most attractive features—the lack of a fee.

Low-Fare Shuttles Proposed by Eastern

Washington—Low-fare shuttle coach service on the high-density Boston-New York and New York-Washington routes has been proposed by Eastern Air Lines.

The service, to begin Apr. 16 if Civil Aeronautics Board approves, involves use of large piston-engine aircraft to provide service at regular intervals during the day in each direction on the two routes. The shuttle service would fill a need outlined in Examiner Paul Pfeiffer's report on the New York Short-Haul Coach Investigation (AW Dec. 19, p. 43).

In order to compete with ground transportation, Eastern has eliminated all frills, and there will be no reservations. Passengers may purchase tickets in advance or on the aircraft, but a ticket does not constitute a reservation. Boarding passes will be issued on a first-come, first-serve basis at the airport. In case of an overflow, Eastern plans to have backup aircraft ready.

By charging a low air fare—$12 New York-Boston and $14 New York-Washington vs. $11.58 and $10.65 by rail coach for the same routes—Eastern hopes to attract new traffic that is either moving by other means of transportation or not at all.

FAA to Use C-135 Flight Data In Airways System Research

By David H. Hoffman

Washington—Federal Aviation Agency plans to use data collected by two heavily instrumented Boeing C-135 transports in a broad exploration of phenomena affecting Visual Omni Range and TACAN signals along U.S. high-altitude jet airways.

Equipped with eight VOR and four TACAN receivers, each of the aircraft can check the 75,000-mi. jet airway complex in 60 to 90 days, recording station output under widely varying atmospheric conditions. Computer analysis of this data may explain some of the unpredictable qualities of VHF signal propagation at altitudes above 24,000 ft.

The first C-135, purchased in a basic Strategic Air Command tanker configuration for $2.6 million, entered service this month after 30 days of shakedown and transition flying. Modification and instrumentation of the second C-135 now is under way. When this aircraft becomes operational in August, FAA predicts that its high and intermediate altitude inspection fleets will be "adequate" for the next 15 yr.

Three Consoles

Three consoles have been installed in each C-135 cabin. The first and third consoles house VOR and TACAN receiving instruments—conventional position deviation indicators, radio magnetic pointers, bearing selectors and distance meters. Readouts from these gauges also appear as permanent traces on a tape rolling through a 36-channel, oscillograph-type photographic recorder.

As this data is collected, an electronic specialist behind the middle console uses a Systron electronic counter to plot the aircraft's precise position. The counter accomplishes this on command every 45 sec. or so by recording the number of microseconds consumed by pulses traveling from the aircraft to a pair of VOR/DME stations and back. All position fixes are keyed to the oscillograph tape automatically.

On routine periodic check flights, the first console's receivers are tuned to the stations that define the jet airway segment being flown. The receivers of the last console measure the reception, sensitivity and alignment of VOR radials intersecting the airway course at various angles. Thus the fully instrumented aircraft can simultaneously check almost all VHF facilities contained by a block of airspace up to 360-mi. long and 300-mi. wide.

This system does more than check individual station output for accuracy, however. It also furnishes FAA with a permanent, easily accessible record of each station's signal characteristics at altitude, a valuable tool for planning purposes. For example, a station with an unusually large or irregularly shaped cone of ambiguity directly above it could not be used as a jet traffic holding fix; a station with misaligned radials could not be used for jet penetrations.

After en route facilities have been checked several times, analysis of their coded records by an International Business Machines Corp. 704 computer at FAA's Oklahoma City aeronautical center may help solve these among other jet route problems:

- **Lack of uniformity** in the minimum reception altitudes (MRA) of comparable VOR and TACAN installations. FAA has found that these MRAs may vary unaccountably from station to station despite favorable conditions around the antenna sites. As a result, a VOR installed to anchor a high altitude airways segment may prove useless to en route aircraft above, say, 35,000 ft., yet prove perfectly usable at lower flight levels.
- **Polarization of VHF navigation** aid signals. Because of polarization, pilots frequently note that in banks, climbs or descents at altitude, their deviation indicators display abnormal readings. Absence of accurate course information could prove dangerous, especially in prolonged climbs or descents. FAA, therefore, has limited allowable polarization to between one and two degrees.
- **Unpredictable positioning** of high-altitude signal lobes. It has long been known that the propagation of VHF lobes, or lobing, is a dual function of antenna height and transmitter frequency. For a given VORTAC station, however, the precise position of the teardrop-shaped areas of adequate signal strength must be chartered by flight checks. If these uncover critical "gaps," modification of the ground station is often called for.

B-57 Program

Earlier operation of modified Martin B-57 bombers to commision and check the 200-odd VORTAC and VOR/DME stations included in the jet airway structure convinced FAA that this type of aircraft couldn't cope with the job. Two C-135s, on the other hand, can substitute for about 10 B-57s if FAA can fly the new aircraft 1,500 hr. per year or 6 hr. per working day as programed.

FAA feels that the manual character of its high altitude inspection system has a built-in flexibility not quite shared by the Semi Automatic Flight Inspection (SAFI) system designed for the five Convair 440 aircraft that FAA will operate in checking intermediate and low altitude airway structures (AW Dec. 19, p. 32).

These aircraft, the last of which will be equipped with turboprops in October, are guided in flight by tapes produced by FAA's IBM computer and follow grid rather than airways courses. If the SAFI system proves satisfactory, Arthur Jenks, chief of FAA's aircraft operations and procedures branch, reports that the agency will consider installing it on the Boeing aircraft. Even without SAFI, however, Jenks believes that each C-135 will do the work of four Convairs.

Fiscal 1962 Subsidy Estimated for Airlines

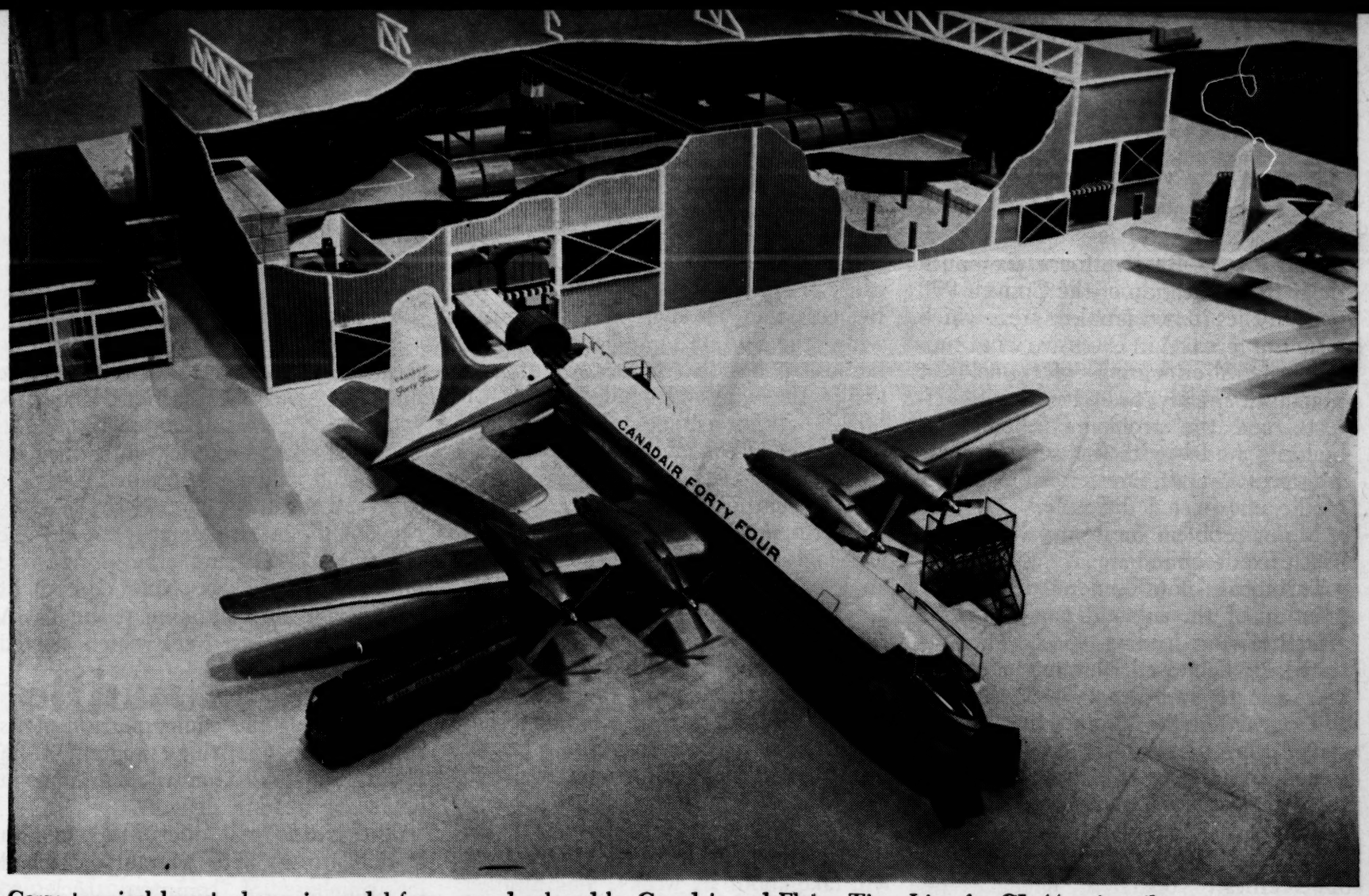
Washington—Subsidy for certificated U. S. airlines will total over $84.3 million for the next fiscal year, according to estimates by the Civil Aeronautics Board.

Fiscal 1962 estimate includes $68 million—80%—for local service airlines. The $6-million increase in subsidy over this year reflects the continuing cost of new equipment and the addition of new routes operated with low-density schedules.

CAB expects subsidy to increase for local service carriers during the next few years, but it refuses to predict when or whether the local service airlines will become self-sufficient.

Other subsidy categories for Fiscal 1962:

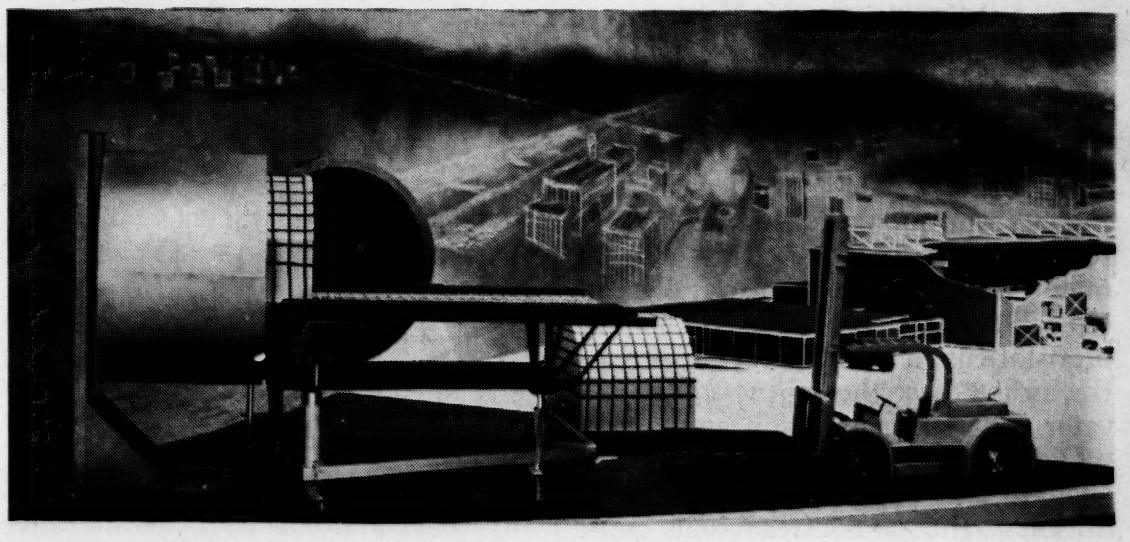
- **Domestic trunklines** are all operating subsidy-free, as they have been since 1960.
- **U. S. international carriers** are all operating subsidy-free except for one which has a claim for subsidy before the Board.
- **Alaskan carriers**—both intra-Alaska and mainland-Alaska—will require about $9.2 million in Fiscal 1962, compared with $8.6 million for this year. CAB feels that subsidy for Alaskan carriers will remain about the same in the future.
- **Hawaiian carriers** are operating subsidy-free this year and will be next year, but both airlines serving the islands have claims for subsidy before the Board.
- **Helicopter airlines** have been estimated to need $6.9 million for Fiscal 1962, compared with $5.2 million this year. CAB says the increase is the result of the three carriers' plans to re-equip with twin-engine, turbine-powered aircraft.

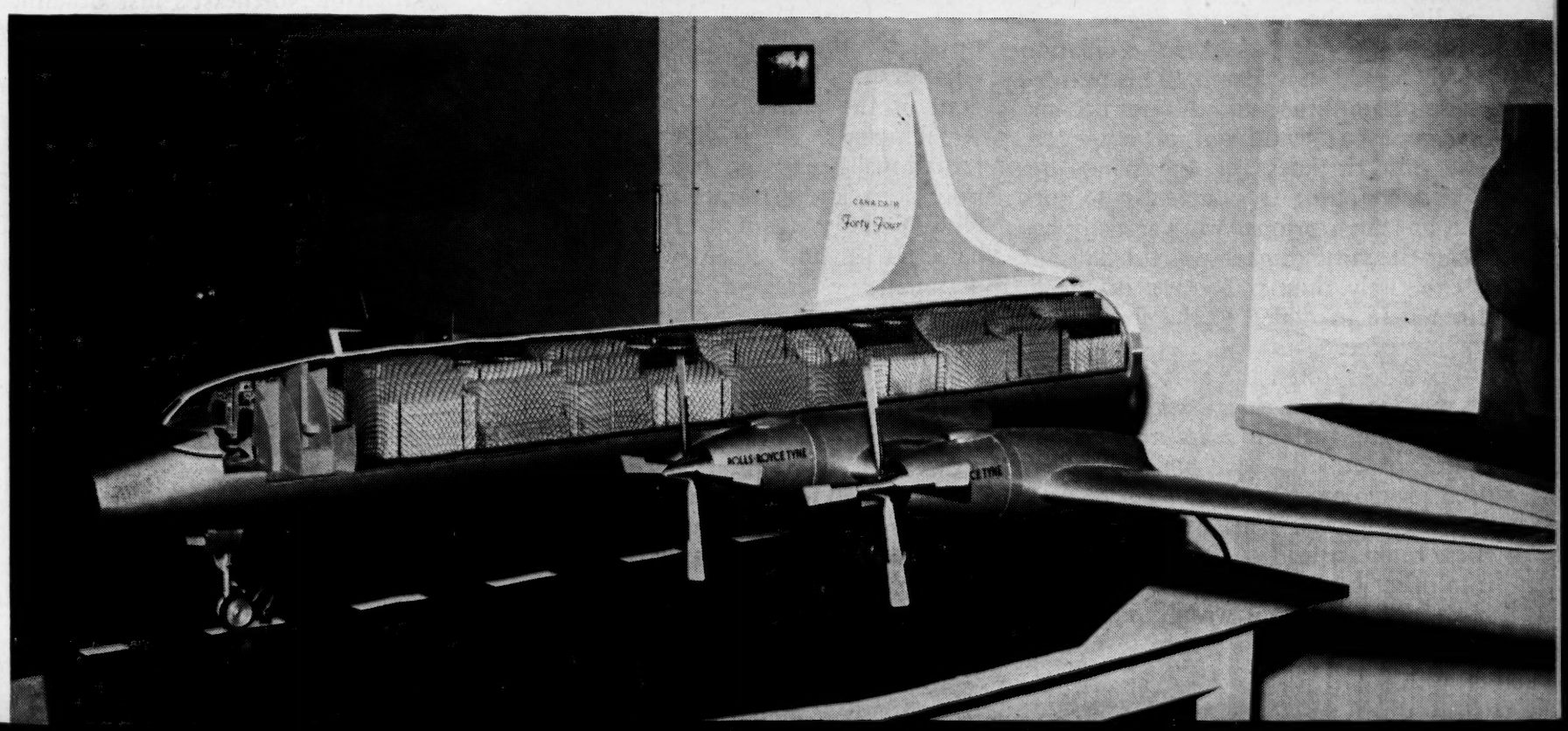


Cargo terminal layout, shown in model form, was developed by Canadair and Flying Tiger Line for CL-44 swingtail operations.

Canadair and Flying Tiger Develop Cargo Complex

Highly mechanized cargo handling and loading concept, developed by Canadair and Flying Tiger Line for the CL-44 swingtail turboprop transport, calls for airplane turnaround time of 1 hr., against 5 hr. by hand methods. At right is model of a load leveling platform, designed by Canadair, which automatically adjusts to fuselage sill deflections. All-mobile platform mounted on a truck is nearing completion. Terminal, which will be built at O'Hare Field, Chicago, by Flying Tiger, handles packaging of cargo envelopes which are mounted on pallets and slide into the CL-44. Plane has cargo capacity of 66,128 lb.





Convair 990 Modifications to Delay FAA Certification for Six Months

San Diego—Reason for a six-month delay in certification of the Convair 990 basically lies in two problem areas which were not revealed in extensive wind tunnel tests. Shortcomings of tunnel test programs, mainly tunnel and scale effects, and the problems inherent in building models with the same stiffness as actual aircraft, are probable causes of the unexpected difficulty.

Major problem areas and the established fixes required are:

• **Turbulent flow generated** at the junction of the inboard engine pylons and the wing leading edge. This resulted in decreased elevator effectiveness due to turbulence over the tail and prevented the aircraft from being stalled in a landing configuration. When trimmed at 1.2 V_{stall}, the elevator did not have enough effectiveness to stall the aircraft without more trim.

Fix for this problem is the addition of electrically operated, Kreuger-type flaps in the wing leading edge between the fuselage and the inboard pylons. An aerodynamically tight seal is effected between the flap and the pylon to control the turbulence previously generated in this area. Kreuger-type flaps resembling flat plates are in use on modified Boeing 707 and 720s.

• **Elevator effectiveness available will be** increased by a mechanical change and an aerodynamic change. Mechanically, the tab control linkages will be changed to permit the tab to drive the elevator more effectively. Aerodynamically, the tab will operate more effectively because of a slot cut in the elevator to increase the airflow over the tab when the elevator is at large deflection angles.

• **Outboard engine oscillations** due to engine size, pylon length and wing thickness ratio. Under steady-state cruise conditions, the outboard engine pods exhibited a limited cycle oscillation which would not damp. This was of constant amplitude and did not become divergent but could not be corrected. The 8% thickness of the wing precluded stiffening it sufficiently to support as long a pylon. Wing actually has about the same thickness as the 880 but is effectively thinner because of an additional 15 in. added to the cord at the trailing edge.

Fix is to shorten the outboard pylons by moving the engines back 29 in. To compensate for the rearward shift in center of gravity, fuel tanks formerly used for replenishment fuel will be kept at a higher level. Fuel will be fed into these tanks instead of having them feed into other tanks.

Pod flow problem wasn't picked up in flight testing the Convair 880 because of differences in the two airplanes. Besides the aerodynamically thinner wing, the 990 tail moment is longer because it has two more rows of seats aft of the wing. General Electric CJ-805-23 aft-fan engines also call for a different pod configuration.

Convair does not believe that moving the outboard engines to the rear will present difficulties in foreign object ingestion. Changing the clamshell angle of the reversers on the inboard engines will control foreign object ingestion and the introduction of hot gases from the inboards with the attendant loss of effectiveness on the outboards' reverse thrust if taxi and landing tests indicate this is necessary. Some loss of inboard reverse thrust would result in this case.

First 990 went into layup for the modifications Mar. 21. Modification will take about six weeks. The number two 990 will continue taxi and other system tests before being modified.

Delay in certification from June to December primarily will be necessitated by the need to demonstrate to the Federal Aviation Agency that fixes are not of the "hand built" variety but are production items. This will cause a production slowdown for the length of time necessary to incorporate the changes on a production basis.

Delivery delays will affect American Airlines, Swissair, SAS (AW Mar. 20, p. 34), and Real.

Tillinghast Elected New TWA President

New York—Emergence of Ernest R. Breech as a strong factor in the direction of Trans World Airlines is indicated by the election last week of Charles C. Tillinghast as new president of the airline.

Tillinghast, 50, is vice president-international operations for Bendix Aviation Corp. and a former partner in the New York law firm of Hughes, Hubbard, Blair and Reed. This is the personal law firm of Breech, who is one of two voting trustees of Howard Hughes' TWA stock named by the lending institutions. Breech also was recently elected to an expanded board of directors of TWA. The law firm also serves Bendix, whose president from 1942 to 1946 was Breech.

Tillinghast's background is primarily in corporate law and finance rather than airline operation, indicating what the board feels are the broad problem areas for the airline. The choice was played close to the vest by the board, and there was little advance inkling of the selection even among top level TWA management. There had been some early reports that a man with a strong airline background was being sought, or that the choice would be made from within TWA.

Financing problems have by no means been solved for TWA. While financing for the carrier's jet program so far is nearing completion, additional jet orders in the future may involve some additional financing.

TWA technical officials favor Boeing equipment for further needs—the turbofan 720B and the long-range turbofan 707-331B. New equipment was an item for discussion at the TWA board meeting last week which elected the new president.

TWA is now working with lenders in completing the equity portion of its $265-million financing program from Boeing 707s and Convair 880s now in service or nearing delivery.

The airline will offer $100 million in debentures, with warrants attached for purchase of common stock, to stockholders not later than May 31. Proceeds of the debentures will be used to pay a 6½% note of TWA in this amount that was issued last year as part of payment of $157,241,911 to Hughes Tool Co. for aircraft owned by Hughes Tool and leased to TWA, rental payments for the aircraft and a previous note to Hughes.

Another problem to be faced by the new president and the new board of directors is the question of merging with Northeast Airlines. Northeast proposed this move last May, with a decision deadline of July 31. At TWA's request, month-by-month 30-day extensions have been granted and the issue is still pending.

Charles S. Thomas, last TWA president, resigned July 28, just before the expiration of Northeast's first deadline. Tillinghast is scheduled to assume his duties with TWA on Apr. 17.

CHARLES C. TILLINGHAST

MODEL shows Boeing 727 medium-range aircraft with Lufthansa German Airlines' markings.

Lufthansa 727 Order Encourages Boeing's European Sales Campaign

Geneva—Lufthansa German Airlines' order for 12 Boeing 727s is accelerating Boeing Airplane Co.'s European sales campaign for the medium-range transport.

Lufthansa's order (AW Feb. 27, p. 35) came as a particular blow to advocates of the European Air Union combine which has been urging early standardization of equipment and to de Havilland Aircraft Co. and Sud Aviation, which, with the DH 121 and Sud Caravelle, are the two European manufacturers with transports most nearly paralleling the 727 in performance and mission.

Officially, Air Union partners and the two manufacturers are generally disclaiming the significance of the Lufthansa order.

Competition Denied

Both de Havilland and Sud spokesmen denied to AVIATION WEEK that the heavier 727 is a direct competitor of their particular aircraft. Other European carriers said the order would have no effect upon their own equipment plans and Lufthansa's Air Union partners—Air France, Alitalia and Sabena—are maintaining a calm front.

It is known, however, that at least some Air France officials and Sud executives were particularly displeased. While the proposed Air Union charter does not specifically demand that equipment of its members be standardized, it does provide for consultations before an order is placed.

A Lufthansa spokesman, while agreeing that Air Union was not particularly pleased by the move, said the members had been "warned" of the order in advance. An Air France official contended, however, that the French carrier had not been "consulted" about the choice.

Spokesmen for the German airline pointed out that Air Union also had been upset by the carrier's order for eight Boeing 720Bs, the first of which was delivered earlier this month. But, he added, that Lufthansa "has never considered" withdrawing from the project and is "still intent" upon participation.

An official of Sabena Belgian World Airlines said the carrier was surprised by the Lufthansa decision but pointed out that, thus far, all Air Union partners have continued to follow separate policies in the purchase of aircraft best suited to their particular route structures and needs.

The need for standardization, the Sabena spokesman said, would not become critical until the introduction of supersonic transports, whose purchase price, maintenance and spares cost would make independent operation by a single carrier prohibitive.

No Impact

Sabena, Air France and Alitalia all agreed that the Lufthansa decision will make no impact upon their choices of equipment—as did non-union airlines recently polled.

In fact, most public concern over the possible effect the 727 order could have upon Air Union's future came from the non-members polled, and, if nothing more, it has increased the speculation as to whether Air Union will ever become something more than a loosely-knit consortium with no real force. Sabena has openly hinted that it has had second thoughts as to the effects a close alliance would have upon its rights for independent action.

As far as the medium-range controversy is concerned, Sabena said it is "completely satisfied" with its Caravelles and has "no thought" of ordering another medium-range type. Alitalia, which is now operating 4 Mk. 4 Caravelles and has 10 Mk. 6s on order, said substantially the same thing.

Air France, of course, has close political and national ties with Sud and is satisfied with its present Caravelle equipment operation. Any subsequent orders for medium-range equipment undoubtedly would be for advanced versions of the Caravelle.

The projected Caravelle 10, to be powered by the 14,000-lb.-thrust Pratt & Whitney JT8D engine, and the DH 121 both have initial delivery dates roughly comparable with those Boeing says it can offer any subsequent European buyers of the 727—mid-1964.

And, despite the official lack of concern or interest in the Lufthansa order by manufacturers and airlines alike, several other European carriers who have studied both the 121 and Caravelle 10 have asked for details on the 727.

Of the airlines still uncommitted in the medium-range field, KLM Royal Dutch Airlines, which needs a replacement for its Lockheed Electra turboprop in the mid-1960s, has shown the most interest in the 727 thus far. KLM also is considering the Convair 990 as an Electra replacement.

TCA Records First Deficit in 10 Years

Montreal—Trans-Canada Air Lines reported a net loss of $2,607,350 for 1960—its first financial deficit in 10 years.

Total revenues for the year were $148,986,526. Total passengers carried increased 7% to 3,440,303, and available seat miles increased 13% to 3 billion. Over-all passenger load factor was 66%, compared with 66.5% experienced in 1959.

The loss was attributed to a reduction in average return per seat mile and to heavy expenses of introducing two new aircraft, the Douglas DC-8 turbojet and the Vickers Vanguard turboprop.

Major rise in the proportion of economy-class seats resulted in a decline in average return from 6.31 cents to 6.24 cents in North American services. Exceptional training costs in connection with the new aircraft amounted to $1,384,000.

Payments for the new planes and new ground equipment and facilities at Montreal totaled $87,006,000.

999,000 BUSINESSMEN WILL READ THIS NEWS ABOUT LOCAL SERVICE AIRLINES*

News of Local Service Airlines

Texaco offers this series of informative bulletins in recognition of the vital new dimension being added to business activity by local service airlines. Texaco Inc., Aviation Sales Department, 135 East 42nd St., New York 17, N. Y.

They've already read ads like this in past issues of *Business Week*. And they'll be reading new ads in future issues—all telling them how Local Service Airlines are contributing to American business activity.

Texaco, who supplies many of these airlines with a full line of fine aviation fuels and lubricants, is pleased to present this series in the public interest.

*Based on an average readership of 2.7 per copy of Business Week.

Special local transport airline flights make unusual contract obligations possible. Thanks to flexible local transport airline facilities, business men now often find it possible to fulfill contract obligations in a manner unheard of a generation ago.

Take the huge Ballistic Missile Early Warning System that RCA is building for the Defense Department. Since the project is near Fairbanks, Alaska, close communications with company headquarters posed a problem.

The solution was found when RCA contracted **Alaska Airlines** to operate a once-weekly round-trip flight service between Philadelphia and Fairbanks. Flights involve 6,866 round-trip miles per week . . . a total of over 300,000 miles for the year. Cargo includes both men and materials.

Air freight expands to include direct ground link. Local service airlines make it possible to fly freight into practically any city in the U.S. Last year, local carriers moved over 5 million tons of air freight—a 200% increase over 1950.

Now, shippers in the Arkansas-Louisiana-Texas area can take advantage of a new convenience offered by **Trans-Texas Airways.** On May 1, the Railway Express Agency began door-to-door pickup and delivery for Trans-Texas—a direct ground link for their air freight traffic.

Local carrier "watch dog" service protects nation's timber stands. Stranded vessels have been saved. Strayed livestock recovered. Fishermen rescued. Power line breaks discovered. All because of the vigilance of local carrier flight crews. But perhaps the most valuable "watch dog" service these men perform is detecting and reporting forest fires.

Pacific Air Lines flights, for instance, cover 26 national forests as well as many of the nation's most valuable stands of timber. Last year, Pacific flight crews alerted state and national forest firemen to fires in many areas—thus helping prevent the loss of millions of dollars worth of standing timber.

Local carriers offer exciting vacation tips for the time- and budget-conscious. Because they cover the entire United States, local service airlines offer almost unlimited vacation possibilities. Skiing, skin-diving, sight-seeing, bull-fight attending—to name just a few. Vacation planners find local carrier facilities especially helpful in planning short or inexpensive vacations. **Bonanza Airlines** flies vacationers to all the scenic wonders and famous winter resorts of the Southwest—including fabulous Las Vegas. **Trans-Texas Airlines** schedules week-end flights at special rates to the colorful old cities of Laredo and Nuevo Laredo. Or, for something different, travelers can get a breathtaking view of the Hawaiian Islands from **Aloha Airlines** sightseeing planes. Special lens windows let shutterbugs take undistorted shots of nature's grandeur below.

Central Airlines offers perhaps the **shortest** vacation on record. As part of its regular service, it schedules 20-minute, Sunday afternoon "Scenic Flights" over the 36 cities in its area. The cost? Just $2.50.

Roster of local service airlines

Alaska
Alaska Coastal
Allegheny
Aloha
Bonanza
Caribair
Central
Cordova
Ellis
Frontier
Lake Central
Mohawk
North Central
Northern Consolidated
Ozark
Pacific
Piedmont
Reeve Aleutian
Southern
Trans-Texas
West Coast
Wien Alaska

TEXACO INC., AVIATION SALES DEPARTMENT, 135 EAST 42nd STREET, NEW YORK 17, N. Y.

SAS SUD CARAVELLE at Stockholm's Bromma Airport. International operations will be shifted from Bromma to Arlanda by next year.

European Travel to U.S. Spurred by SAS

By Cecil Brownlow

Stockholm—Scandinavian Airlines System is embarking upon a vigorous policy of encouraging European travel to America, in an effort designed to bolster the carrier's sagging financial posture.

Smarting from a $16.8 million operating loss last year (AW Mar. 20, p. 34), and with prospects less than optimistic for the current year, the program is aimed at offsetting the heavy expenditures involved in the transition to jets, rapid depreciation of piston equipment and the need for multiple headquarters and facilities in the tripartite partners—Sweden, Norway and Denmark.

The plan is essentially the second shoe of a similar, and highly successful, campaign touched off several years ago to convince Americans that Copenhagen is the "gateway" to Europe.

In 1960, SAS flew approximately 120,000 passengers on east and westbound flights across the Atlantic, the large majority of them U.S. citizens and only about 20,000 of them Scandinavians.

In an effort to overcome this imbalance and boost load factors as a whole, SAS this spring is touching off a "visit U.S.A." campaign aimed primarily at spurring European travel agents to promote the idea among their clients and through promotional displays.

First workshop, largely staffed by American speakers representing U.S. airlines, tourist facilities, land transport and the hotel industry, was held in Copenhagen in early March and followed by similar sessions in Paris, Stockholm and Oslo. Other meetings were scheduled for Helsinki and Hamburg.

At the Copenhagen session moderator Erik Palsgaard, SAS regional sales manager for Denmark, termed the program "a big venture. . . . We want to fill our seats."

Target of the program, as outlined in official brochures, "is a 300% increase in travel to the U.S. in the next four years." Some officials believe the target date may be optimistic, and all agree that the program cannot be viewed as a short-term, quick-payoff project.

K. A. Kristiansen, SAS vice president-sales, told AVIATION WEEK that such a program represents "a slow process. It is certainly going to take four, five or six years before you really feel the impact of it."

Kristiansen and other SAS spokesmen emphasized that there must be some agreement within the International Air Transport Assn. to lower transatlantic fares in order to attract new customers "and take care of this tremendous capacity problem" stemming from the introduction of high-density jet transports by the international carriers.

SAS, "for quite some time," according to Kristiansen, has urged IATA to agree upon "all-year excursion fares," and Palsgaard told the Copenhagen workshop that, at the very least, the airline hopes to see the winter-month 17-day excursion fare rates extended to 23 days.

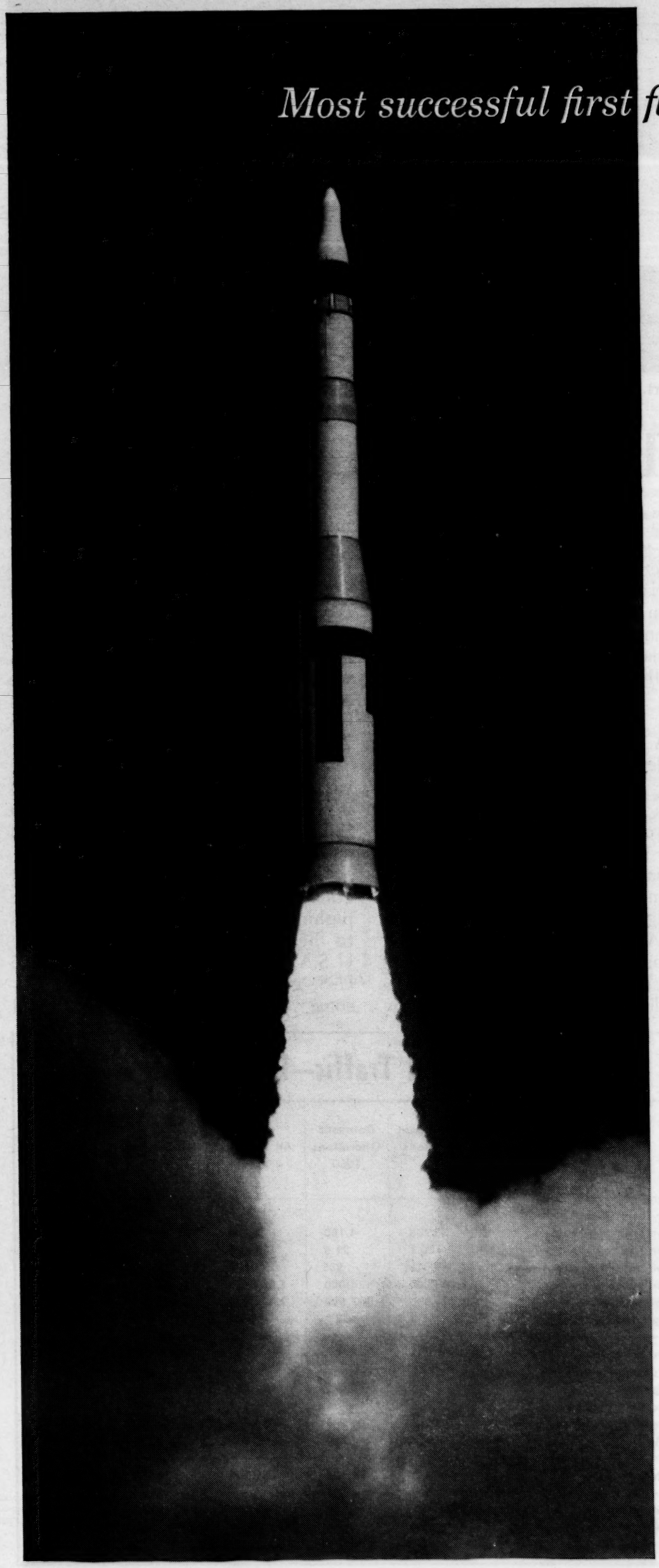
"Almost all Europeans have three weeks' vacation," Palsgaard said, "and it would be unacceptable to them to think of taking a trip of a lifetime and cutting it short after two weeks."

In this respect, Palsgaard noted that other international carriers also are pushing similar projects as follow-ons to the not overly successful "visit the U.S.A." program sponsored by the U.S. government last year. "We welcome such competition," Palsgaard

SAS Scheduled Traffic—1959, 1960

	International Operations 1960	Domestic Operations 1960	All Services 1960	All Services 1959	% Change
Revenue miles flown	33,900	4,100	38,000	36,800	3.2
Revenue hours flown	120.1	21.5	141.6	149.8	−5.5
Revenue passengers carried	1,346	535	1,881	1,642	14.6
Revenue passenger miles	1,240,000	124,000	1,364,000	1,180,000	15.6
Available seat miles	2,223,000	197,000	2,420,000	2,042,000	18.5
Passenger load factor	55.8	63.1	56.4	57.8	−1.4
Revenue ton miles:					
(A) Passengers and free baggage	110,523	10,270	120,793	105,554	14.14
(B) Excess baggage	1,108	36	1,144	1,143	0.0
(C) Freight	25,285	578	25,863	20,708	24.9
(D) Mail	7,454	700	8,154	6,878	18.6
Total	144,370	11,584	155,954	134,282	16.1
Available ton miles	266,156	20,553	286,709	239,652	19.6
Over-all load factor	54.2	56.4	54.4	56.0	−1.6

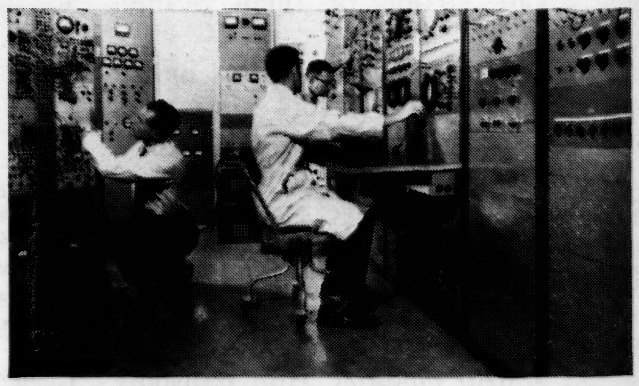
Most successful first flight in missile history



Historic first firing of Minuteman, the U. S. Air Force's first solid-fuel intercontinental ballistic missile. Completely successful, this flight marked the first time in history that so many missile components were tested on initial flight: three rocket stages, full guidance system and nose cone. Compact, quick-firing Minuteman missiles, scheduled for operational status by mid-1962, will be stored ready for instant action in underground silos and on special trains. Boeing is responsible for Minuteman assembly and test, design and development of launch control and ground support systems.

Capability has many faces at Boeing

SKY TANKER. Boeing KC-135 jet tanker refuels bombers and fighters to provide greatly extended range. This versatile Boeing jet is also a military transport. The United States Air Force recently ordered 30 C-135s, cargo-jet version of KC-135.



TESTING. TESTING. Boeing electronic system tests effectiveness of radar and countermeasures systems. Boeing is widely active in electronics—in research, design, manufacture and test, and in the assembly of systems for Air Force's BOMARC and Minuteman missiles, and Dyna-Soar space-glider.

BOEING

said, "because this eventually will help to bring the costs [of tickets] down" to a level where more Europeans can afford them.

The present sessions, according to Kristiansen, are timed "a little late for the 1961 summer traffic" since most tourist agents already have booked the majority of their tours for this period, "but they can help in the winter program ahead."

SAS will follow up in the fall with an expanded series of meetings, touching upon the smaller cities of Europe, recontacting agents in the larger centers, to begin pushing the 1962 summer program for both group and individual sales.

Emphasis at the workshop sessions is on low cost, with U.S. airline representatives stressing the economy of their particular package programs. The Eastern Air Lines spokesman, for example, pointed out that Eastern offers a six-day package to Miami in the off-season for $135.60, including hotel room and night coach fare to and from New York.

Sheraton Hotels also is working with SAS on the program, offering special rates to visitors who sign on for an individual or group package tour before leaving Europe. A spokesman for the hotel chain told the workshop audience that a visitor should be able to manage for as little as $12.65 a day for hotels and meals while in the U.S., and Palsgaard said SAS hopes to eventually reduce the figure to $10.00 per day.

An added incentive to the European tourist agent is that he stands to gain an additional 3% in commission by selling a package tour, rather than booking the flight only—10% as opposed to 7% for the latter.

An SAS "travel planner" brochure, containing specific pre-arranged tours—without transportation costs—designed to fit the middle-class European's budget, includes such plans as:

- **Three days in Las Vegas,** including a motor tour to Hoover Dam: $24.00 per person.
- **Four days in Los Angeles,** including trips to Disneyland, Hollywood and the Walt Disney Studios: $38.00 per person.
- **Six days in New York,** with a tour of the city from Greenwich Village to the United Nations, for $49.50 per person.

One of SAS's over-all problems that must be solved is the sharp below-industry-level declines in load factors during the winter months.

"People have the idea that all is ice and snow up here in the winter," Kristiansen says, "and consequently they only come if they have to—primarily on business."

Kristiansen and his sales staff are attempting to combat this on a number of levels. Most sales brochures and posters, for example, point up the warm weather aspects of the northern countries—pictures of a fly fisherman, water skiers, etc. Kristiansen, who plans his sales campaigns one year in advance in an effort to gain maximum coordination, also has provided his salesmen and SAS regional managers with a thick promotional brochure entitled "Pleasant Scandinavia" pointing up the region's various advantages, sights, shopping bargains. "What we must do," he concluded, "is get the idea across that Scandinavia is not some place where you go to freeze to death."

Aeroflot Predicts One-Third Gain In Scheduled Traffic for 1961

By Ernest Conine

Moscow—Aeroflot traffic will increase by about one-third this year over the past year on scheduled runs, according to Evgeny Loginov, chief of Aeroflot.

Writing in Grazhdanskaya Aviatsiya, Loginov noted that a 13% increase is scheduled in "special application" flights also handled by the Soviet Civil Aviation Administration—such as spraying, aerial prospecting, air ambulance and construction missions.

Loginov is urging that in 1961 personnel of the Soviet airline be more cost-conscious, safety-conscious and determined about adhering to flight schedules. Passengers also must be treated in a "more cultured" way, he said.

Jet and turboprop aircraft already occupy the "main place" in Aeroflot schedules, Loginov said, and will increase more this year with the addition of the turbojet Tupolev Tu-124 and the turbine Mi-6 helicopter.

He said 62% of the passengers this year will ride jet (apparently pure jet) planes.

Loginov repeated past promises that the Tu-114 will "in the nearest future" begin nonstop passenger flights between Moscow and Khabarovsk, thus saving two intermediate landings and two hours' travel time. The Ilyushin Il-18 is flying directly between Moscow and Magadan (AW Jan. 23, p. 43), thus saving six hours over the previous route via Khabarovsk.

The Aeroflot chief noted that one result will be freeing intermediate airports—apparently Novosibirsk, Sverdlovsk, etc.—from servicing long-haul planes, thus allowing greater short-haul traffic between points west and east of Siberia, Yakutsk, etc. Also, establishment of parallel routes should allow fewer weather cancellations.

Observers, mindful of criticism of Aeroflot in past months, noted that Loginov put more than the usual emphasis on ground services, passenger relations and better air-ground coordination.

Calling on flight crews to be neat in appearance, he said "the party has repeatedly said that increasing the culture of services to passengers is an important task. This year should be the turning point" in making Aeroflot the best in the world in this regard.

Loginov also called for better terminal passenger facilities, better transportation to the airport, and provision for precise information on the times of takeoffs and landings. He said luggage handling on arrivals and departures should take no more than 20 min. each.

Schedules should be made where possible for landings and takeoffs at terminal airports between 7 a.m. and 11 p.m. (midnight operations are not unusual now).

Major points made by Loginov were:

- **Cost-cutting efforts.** He said each 1% reduction in cost per flying hour means five-million rubles' savings (a ruble is officially worth $1.11). He called for more efficiency by air crews, tightened operation of maintenance shops and reduction of idle time.
- **Safety.** He emphasized safety as a prime consideration. He said runways are being built and improved and radio landing aids and high-intensity lights are being installed. He called for better training of pilots, particularly on instrument approaches.
- **Observing schedules.** He stressed the importance of observing flight schedules and called for improved weather forecasting and better air-ground weather communications.

Grazhdanskaya Aviatsiya carried another story complaining about the waste resulting from faulty weather forecasts and communications.

For example, one Tu-104 going from Moscow to Tashkent was routed by way of Sverdlovsk because of poor weather at Tashkent. Sverdlovsk reported good weather until the aircraft was beginning to let down—then the airport said that because of bad weather the Tu-104 could not land. The aircraft proceeded to Tashkent where the weather had meanwhile cleared. But the flight had wasted 3 hr. 25 min.

The article said that in the last half of 1960 one subdivision alone had 40 instances of jet aircraft turned away from their destinations because of faulty weather forecasts.

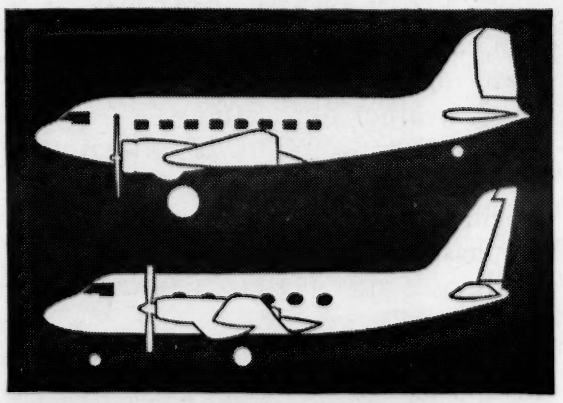
THE GRUMMAN GULFSTREAM
in a brand new "off-the-shelf" military transport version

- **for air evacuation**
- **for facilities inspection**
- **for high-priority personnel and cargo transport**

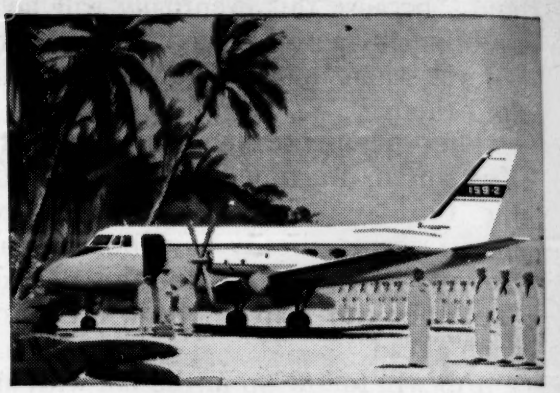
Military transports of World War II and Korea vintage performed admirably. But today they deserve to be retired as befits any battle-weary veteran.

Typical of such transports is the DC-3—one of the finest, most reliable airplanes of its day. Its size, and ability to land and take off from virtually any military field, made it an extremely flexible transport. It has served faithfully in many roles over the past 20 years and has proved to be an excellent military investment. The Grumman Gulfstream is ready to serve as the optimum in military transport for the *next* 20 years, and as a comparable investment.

In the illustration, right, you see two airplane silhouettes: the first, a DC-3; the second, a Grumman Gulfstream. Note how closely they coincide in size. The Gulfstream is the modern pressurized, high performance replacement for the DC-3 and other older transports; equivalent to the DC-3 as a work horse transport—and costing even less to operate—the Grumman Gulfstream is a new airplane proved in service by over 60 world-wide corporations and the Federal Aviation Agency. Modernization of our country's airlift capacity for limited or brush fire warfare can be accelerated by the Grumman Gulfstream. And it's available *now*.

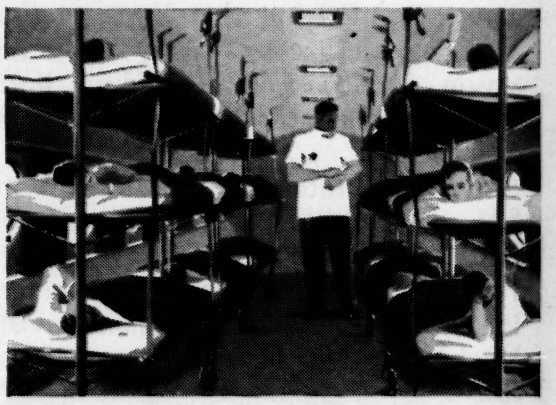


Gulfstream compared to DC-3



Facilities inspection

Here are the Gulfstream's capabilities: For military application, it will carry up to 24 passengers and has a transcontinental range against 50-knot head winds. It needs only 3,000 feet of runway, enabling personnel to use fields close to their destinations. It is completely independent of ground



Air evacuation

handling facilities. With its pressurization system (up to 30,000 feet), it flies above weather and traffic at a cruising speed of 350 mph and is powered by proven turboprop Rolls-Royce engines. An active development program is in progress at Grumman for the installation of the General Electric T64 turboprop engine as an alternate source of power.

Multipurpose Gulfstream cabin

GRUMMAN

AIRCRAFT ENGINEERING CORPORATION

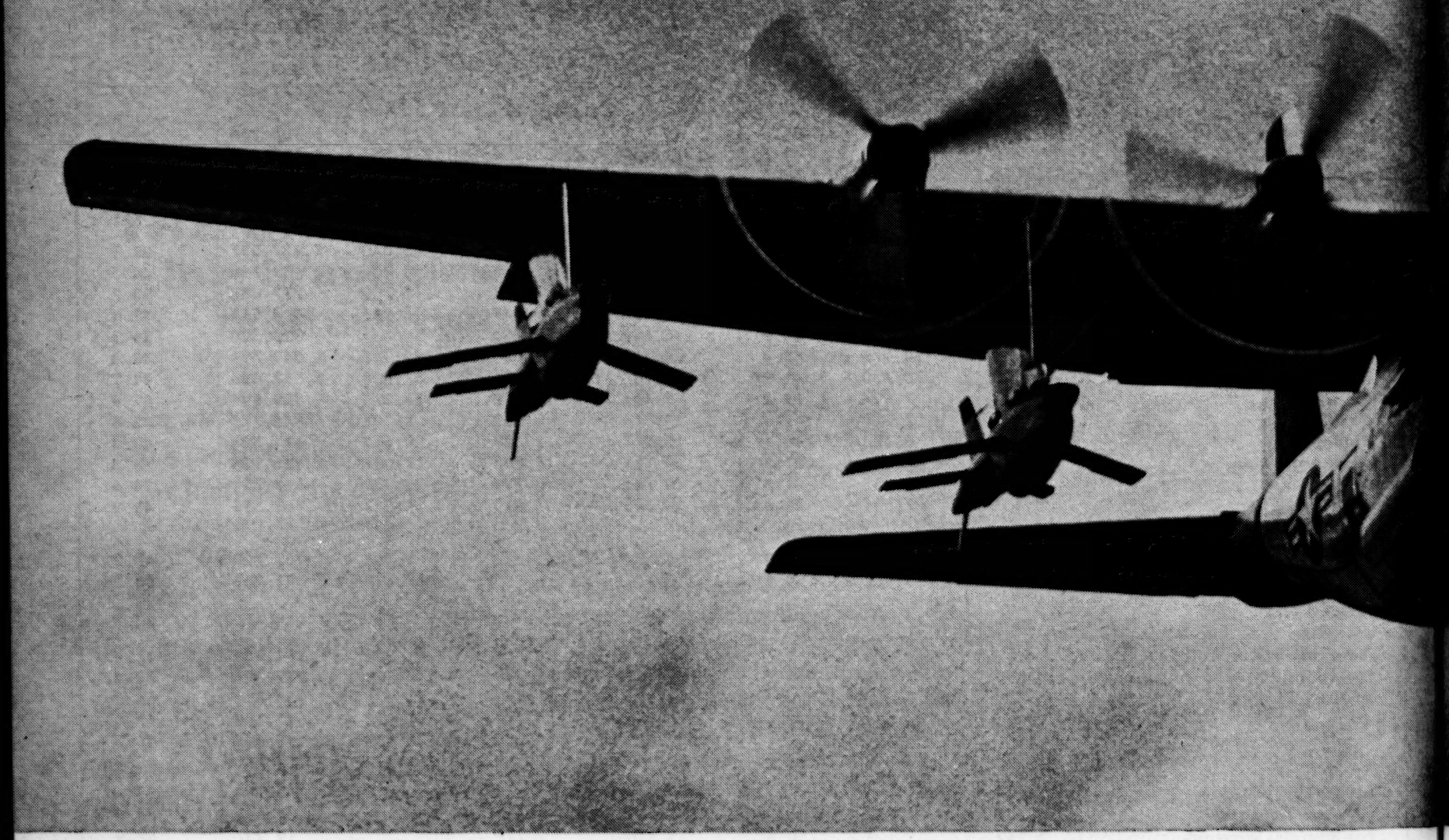
Bethpage • Long Island • New York

Airline Traffic—January, 1961

	Revenue Passengers	Revenue Passenger Miles (000)	Passenger Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-all Revenue Load Factor %
DOMESTIC TRUNK								
American	654,980	490,332	60.9	2,060,086	915,304	8,447,621	58,518,912	53.5
Braniff	200,686	86,138	56.5	362,700	178,433	636,332	9,451,527	44.4
Capital	290,513	119,329	50.2	551,886	282,906	464,826	12,761,315	45.9
Continental	115,189	70,727	46.7	196,880	111,232	448,547	7,542,429	38.1
Delta	336,728	177,738	60.2	567,938	281,566	1,095,530	19,055,454	49.6
Eastern	689,634	352,737	51.3	1,313,671	521,546	1,933,249	37,813,944	40.9
National	149,902	97,135	57.1	329,244	59,903	744,502	10,546,428	44.1
Northeast	119,877	50,592	51.1	133,650	52,052	266,373	5,301,055	42.9
Northwest[1]	.....	.....	.....	.....	.....	.....	.....	.....
Trans World	409,068	334,764	57.9	1,509,193	742,263	4,025,812	38,425,152	47.4
United	663,527	461,566	60.5	3,573,174	1,016,281	7,222,284	56,111,025	52.2
Western	137,178	76,606	57.7	291,056	108,026	328,462	8,047,623	46.6
INTERNATIONAL								
American	7,740	7,894	46.3	10,234	884	303,760	1,125,002	45.1
Braniff	7,367	11,593	47.8	46,257	.....	136,401	1,460,644	45.3
Caribbean Atlantic	34,712	2,419	59.2	2,152	.....	7,799	236,583	58.3
Delta	1,472	2,054	37.9	1,347	.....	13,841	238,956	36.3
Eastern	47,258	72,228	57.4	155,631	.....	305,592	2,205,055	57.4
Mackey	10,547	1,564	48.1	.....	271	9,860	164,183	46.8
National	1,613	852	47.8	259	.....	555	93,121	45.5
Northwest[1]	.....	.....	.....	.....	.....	.....	.....	.....
Pan American								
Alaska	4,382	4,892	46.5	38,608	2,193	116,397	621,636	41.2
Atlantic	104,654	124,752	43.7	1,935,593	.....	3,900,865	18,812,307	40.0
Latin America	103,050	112,287	59.9	403,093	.....	3,676,160	15,446,234	57.5
Pacific	42,561	130,018	58.2	3,398,018	12,297	3,517,929	19,837,839	51.2
Panagra	12,258	16,638	54.9	83,223	.....	539,756	2,417,894	53.7
Resort[1]	.....	.....	.....	.....	.....	.....	.....	.....
Trans Caribbean	11,268	165,747	61.3	.....	.....	228,936	1,105,264	50.9
Trans World	21,693	52,340	41.8	1,321,650	.....	1,297,651	8,017,136	43.3
United	10,910	27,216	60.5	265,948	6,525	129,873	3,168,980	62.9
Western	3,773	5,886	50.1	8,331	.....	22,826	644,837	47.1
LOCAL SERVICE								
Allegheny	53,729	10,870	34.7	23,226	30,886	45,040	1,137,037	37.1
Bonanza	21,654	5,339	39.6	7,627	2,955	8,704	531,710	40.5
Central	14,013	2,640	37.1	8,511	3,874	11,709	277,088	33.7
Frontier	31,315	7,339	37.1	32,157	9,347	56,096	804,917	41.1
Lake Central	21,803	3,187	33.5	6,199	16,595	.....	328,520	36.1
Mohawk	55,849	10,277	40.4	24,513	21,036	22,360	1,049,799	38.4
North Central	91,026	15,430	42.97	47,167	50,336	67,608	1,652,696	44.29
Ozark	44,107	7,924	39.2	19,461	23,898	29,073	829,894	42.9
Pacific	32,892	7,589	42.0	13,014	3,182	8,708	748,725	42.1
Piedmont	33,817	6,525	38.6	11,897	12,528	20,612	671,528	40.3
Southern	28,090	4,994	27.3	20,185	11,793	17,087	528,534	28.8
Trans-Texas	24,721	5,485	37.5	20,185	10,799	32,309	589,721	38.6
West Coast	35,451	7,581	42.89	17,545	5,819	16,237	763,591	43.2
HAWAIIAN								
Aloha	25,353	3,427	56.9	2,774	.....	4,766	282,723	47.2
Hawaiian	33,190	5,407	54.9	3,751	.....	267,420	733,262	58.2
CARGO LINES								
AAXICO[1]	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana	.....	.....	.....	.....	.....	191,054	191,054	67.42
Flying Tiger	3,475	17,474	65.1	1,772,092	35,444	9,077,767	10,922,395	78.8
Riddle—Domestic	.....	.....	.....	25,241	31,445	2,881,325	2,938,011	64.2
—Overseas	.....	.....	.....	5,265	18	551,824	557,107	67.0
Seaboard & Western	.....	.....	.....	1,047,423	.....	2,178,637	3,226,060	46.3
Slick	2,636	17,892	93.9	.....	.....	908,272	2,697,466	95.8
HELICOPTER LINES								
Chicago Helicopter	22,758	357	36.5	1,030	.....	.....	35,097	30.6
Los Angeles Airways	3,142	123	50.6	5,316	2,227	.....	19,337	57.9
New York Airways	10,525	228	66.1	1,717	867	478	24,871	48.9
ALASKA LINES								
Alaska Airlines	9,006	9,687	61.1	63,021	1,139	372,369	1,431,863	67.9
Alaska Coastal	2,954	328	51.7	3,631	.....	4,226	41,178	60.7
Cordova	870	116	33.0	3,848	.....	40,910	56,843	49.0
Ellis	3,190	174	47.2	1,517	.....	1,453	20,665	56.01
Kodiak	748	37	47.3	305	.....	524	4,436	41.41
Northern Consolidated[1]	.....	.....	.....	.....	.....	.....	.....	.....
Pacific Northern	10,319	9,833	52.0	179,006	9,241	351,183	1,606,165	65.8
Reeve Aleutian	1,187	1,042	40.1	46,380	.....	55,308	216,117	57.3
Western Alaska[1]	.....	.....	.....	.....	.....	.....	.....	.....
Wien Alaska	1,681	349	21.8	31,663	.....	46,476	114,527	40.8
Avalon Air Transport	2,749	198	71.3	435	.....	326	19,613	71.3

[1] Not available.

HERCULES is a drone lifter too



There are plenty of reasons why the Lockheed Hercules (GC-130) is an ideal father ship for target drones: speed, altitude, endurance; pressurized, air-conditioned work space for drone directors; high wing for good ground clearance and accessibility; short takeoff and landing. These same reasons, plus a lot of others, make the C-130 Hercules the free world's most versatile and useful cargo airplane.

The big propjet airlifter is now operating or being built in 12 different configurations. C-130s have flown more than a million miles since 1957—and they will fly millions more in years to come. Lockheed Aircraft Corporation, Marietta, Georgia.

LOCKHEED GEORGIA

AIRLINE OBSERVER

► Proposal for an intensified supersonic transport study program has been approved by the Budget Bureau and will shortly be sent to President Kennedy.

► Civil Aeronautics Board delay in issuing its final opinion in the Capital-United merger case may prove costly to United. The carrier wanted to complete full integration of the two companies by Apr. 30 so that consolidation of maintenance and operations facilities would coincide with semi-annual major schedule changes on that date. Since United has been unable to take concrete steps toward merger pending the Board's final opinion, the Apr. 30 target may not be met.

► Trans World Airlines and Convair do not know what Howard Hughes intends to do with the last four of 30 Convair 880s originally ordered for TWA. The airline's refinancing program includes funds for 20 of the transports, all of which are scheduled for delivery prior to mid-May. Earlier, Convair leased six other Hughes 880s to Northeast Airlines. Hughes has a contractual obligation to buy the remaining four, but may not assign them to TWA after having surrendered rights to vote a majority of the carrier's common stock.

► Lockheed's competitors are not conceding the civil cargo aircraft field despite the advantage Lockheed will have in pricing a civil version of the turbofan Air Force C-141 for the commercial market (AW Mar. 20, p. 24). Offsetting a low unit price for airlines are questions on operating efficiency, with cost per ton mile a big question, as well as possible penalties from the military 6,000-ft. runway requirement and capability for 120-kt. flight for dropping paratroopers, neither of which are commercial requirements.

► International carriers are not happy over the prospects of an open cargo rate situation on the North Atlantic and are concerned that governments will take the initiative in negotiating a cargo tariff for the airlines. Thus, chances are strong that another attempt to reach agreement within the International Air Transport Assn. traffic conference will be made soon. Meanwhile, an IATA traffic conference in Bermuda reached agreement on a fare structure for routes in Latin America that promises to bring an end to the rate war that has been raging in that area for more than five years.

► Republic of Guinea this month began expanding the airport at its capital city of Conakry with the help of Russian personnel and equipment. The work is being done under a technical aid pact signed by the USSR and Guinea in March, 1960. Conakry will be served by Aeroflot if the Russian airline gets its desired route down the west coast of Africa. Guinea has expressed interest in acquiring Russian-built Il-18 turboprop transports, and Ghana Airways will operate its new Il-18s through Conakry.

► Braniff, Northeast and Northwest Airlines are building a terminal for joint use at New York International Airport. Building will cost $10 million.

► Sidelight on American Airlines' turbofan conversion of its Boeing 707 transports is that rate of climb of the re-engined airplane requires more careful monitoring of the pressurization system for passenger comfort. System can be operated either automatically or manually, but the increased climb rate of the airplane can easily get ahead of the operator. There is no inherent problem in the system itself, although there was concern early in the flight-test program because of breaks in the duct leading bleed air from the engine to the turbocompressors. These were traced to bad welds in a small batch of ducts, and the problem was quickly corrected.

► Russia's Aeroflot is continuing to place Antonov An-10 turboprop transports on domestic routes at a fast pace. Newest An-10 service is on the 750-mi. route from Moscow to Odessa, which the aircraft covers in 2 hr. 25 min. Twin-engine Il-12 transports previously linked the two cities in 5 hr. flying time. Since the first of the year, An-10s have also been placed in regular service from Moscow to Rostov-on-Don, Skytyvkar, Norilsk, Krasnodar and Lvov.

SHORTLINES

► **Aeronaves de Mexico's** U. S. foreign air carrier permit has been amended to allow service between Mexico City, Washington, and New York, between Mazatlan, Torreon, and Monterrey, Mexico and San Antonio, Texas, and between Hermosillo, Mexico, and Tucson, Ariz.

► **American Airlines** plans to cut air-freight rates 20% Apr. 2 on 27 commodities flown across the country, subject to CAB approval.

► **British Overseas Airways Corp.** has received Civil Aeronautics Board permission to add Philadelphia, Baltimore and Washington as coterminals for its transatlantic route, and Boston has been changed from intermediate point to coterminal. BOAC is barred from serving Baltimore, Philadelphia, and Washington on flights to the Bahamas and/or Jamaica.

► **Civil Aeronautics Board** will be asked to reconsider its southern transcontinental route decision by Sen. Dennis Chavez (D-N.M.) on grounds that Albuquerque was not included in the new routes granted.

► **East African Airways** has ordered a third de Havilland Comet 4 turbojet transport for international service. East African links the United Kingdom with East, Central and South Africa, Pakistan and India.

► **International Air Transport Assn.** has prepared a 420-page book—available Apr. 1—giving shortest operating distances between 1,600 selected cities on the world airline map. The book, entirely written by an electronic data processing machine, will be used to compute fares between 70,000 pairs of points.

► **President John F. Kennedy** has extended to June 20 the reporting deadline for the emergency board investigating the Pan American World Airways-Flight Engineers International Assn. dispute.

► **REA Express** has established a new Air Services Department to integrate management of REA's domestic-international, surface-air operations.

► **Trans World Airlines** will begin nonstop Boeing 707 service from Albuquerque to Los Angeles Apr. 30. By next summer, TWA plans to be operating turbojet service from Albuquerque to Phoenix, New York, Chicago, and Baltimore/Washington.

First!

NOVEMBER 22, 1935 SAN FRANCISCO, CALIFORNIA

When Pan American's new trans-pacific airliner, the China Clipper, soared past the Golden Gate Bridge it opened a new era of air passenger service and formed the first U.S. air link to the Orient. Standard was there!

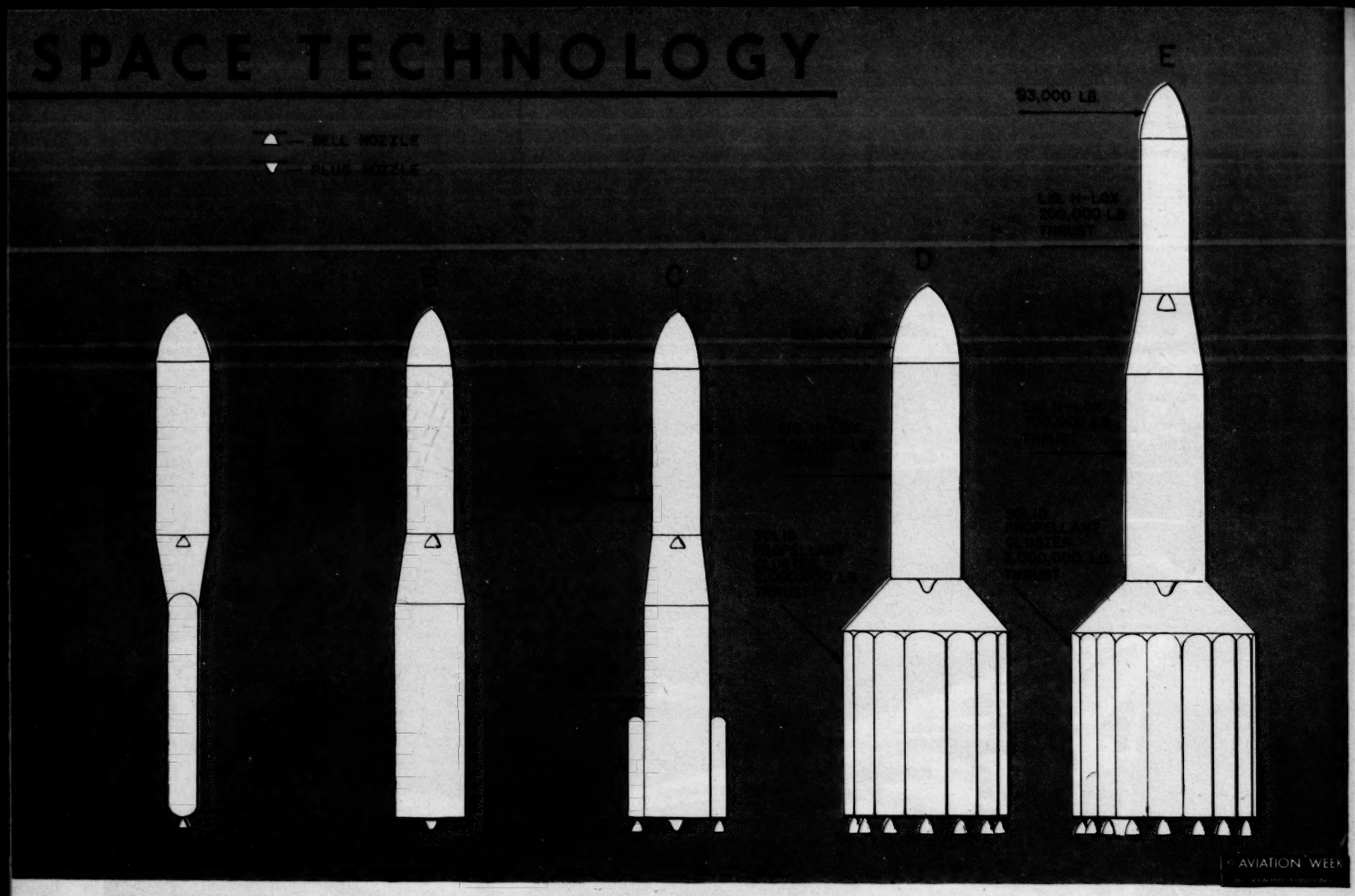
Standard aviation gasoline was the natural choice for this historic flight . . . just as it had been for the very first commercial flights a decade earlier. For Standard developed the first gasoline in the U.S. specifically for aviation.

Today, famous Chevron Aviation fuels and RPM Aviation lubricants fly the jet routes . . . give safe, dependable performance for commercial, business and private pilots everywhere. From "jennies" to jets Standard research has pioneered petroleum products for aviation — and will lead the way in the coming space age.

In the development of supreme quality aviation products . . . Standard is *first!*

Chevron Airport Dealers take better care of your plane — at over 300 of the West's leading airports.

STANDARD OIL COMPANY OF CALIFORNIA

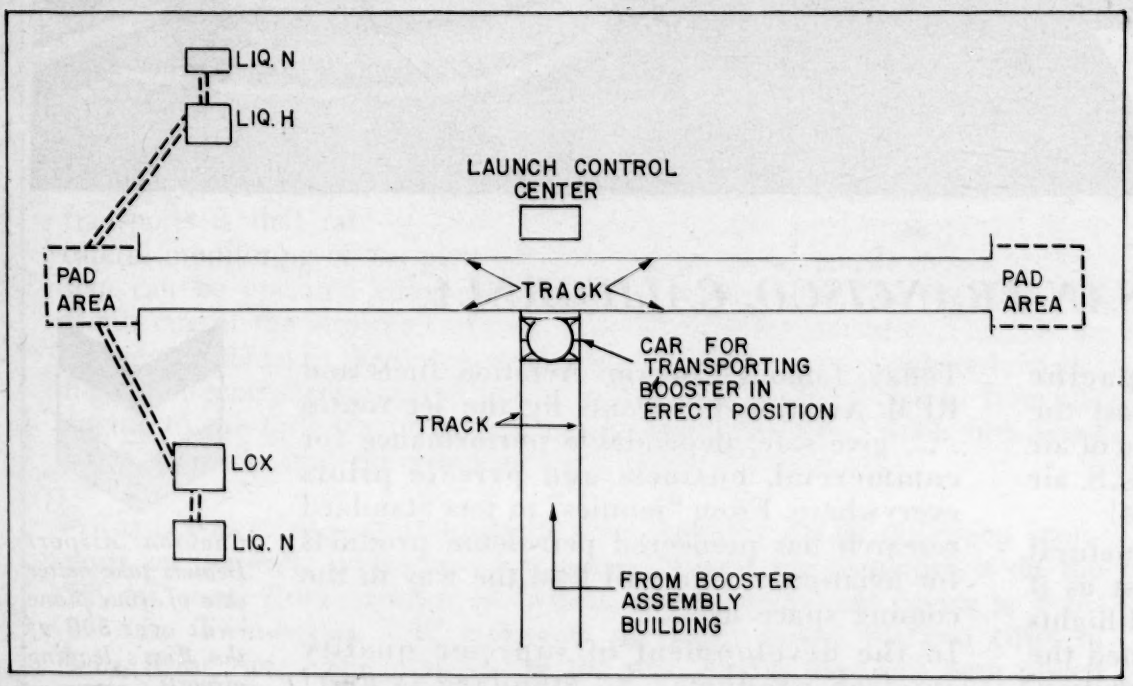


PROJECT PHOENIX Phase II study envisions specific family of boosters with flexible staging to loft spacecraft ranging from 15,000 lb. to 93,000 lb. Booster A (left) with total thrust of 680,000 lb. and weighing 330,000 lb. is projected for greatest utilization under Phoenix, which anticipates Air Force requirements extending through 1975. Other booster combinations may increase thrust to 6,000,000 lb.

Project Phoenix Aims at Economical Super

Extensive study to devise a rock-bottom economy launch system of facilities and rocket boosters for lofting more than 1,000 space vehicles weighing up to almost 50 tons is being advanced by a broad Air Research and Development Command team effort under Project Phoenix to meet Air Force space requirements substantially through 1975.

The system study, scheduled for completion by June 30, is analyzing in detail the application of all the factors affecting efficiency and costs involved in the changing demands of fast-moving space technology.

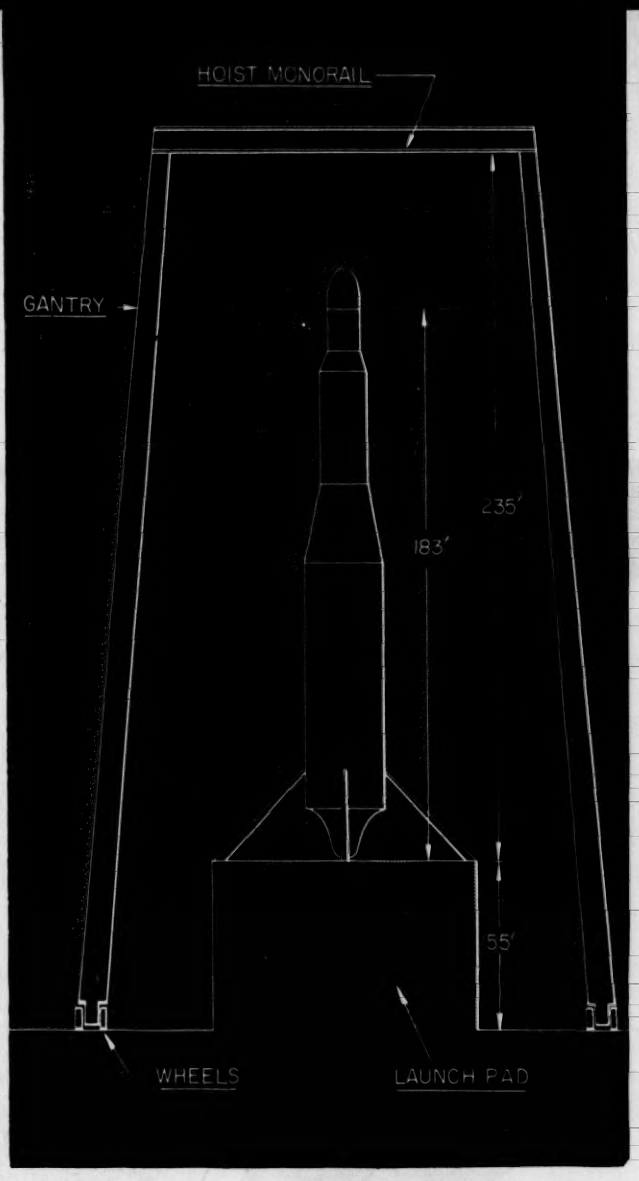


LAND-BASED launch site under Project Phoenix concept would be serviced by system of tracks from booster assembly building. Booster in erect position would be supported on transport table on which booster would be put together, checked in assembly building.

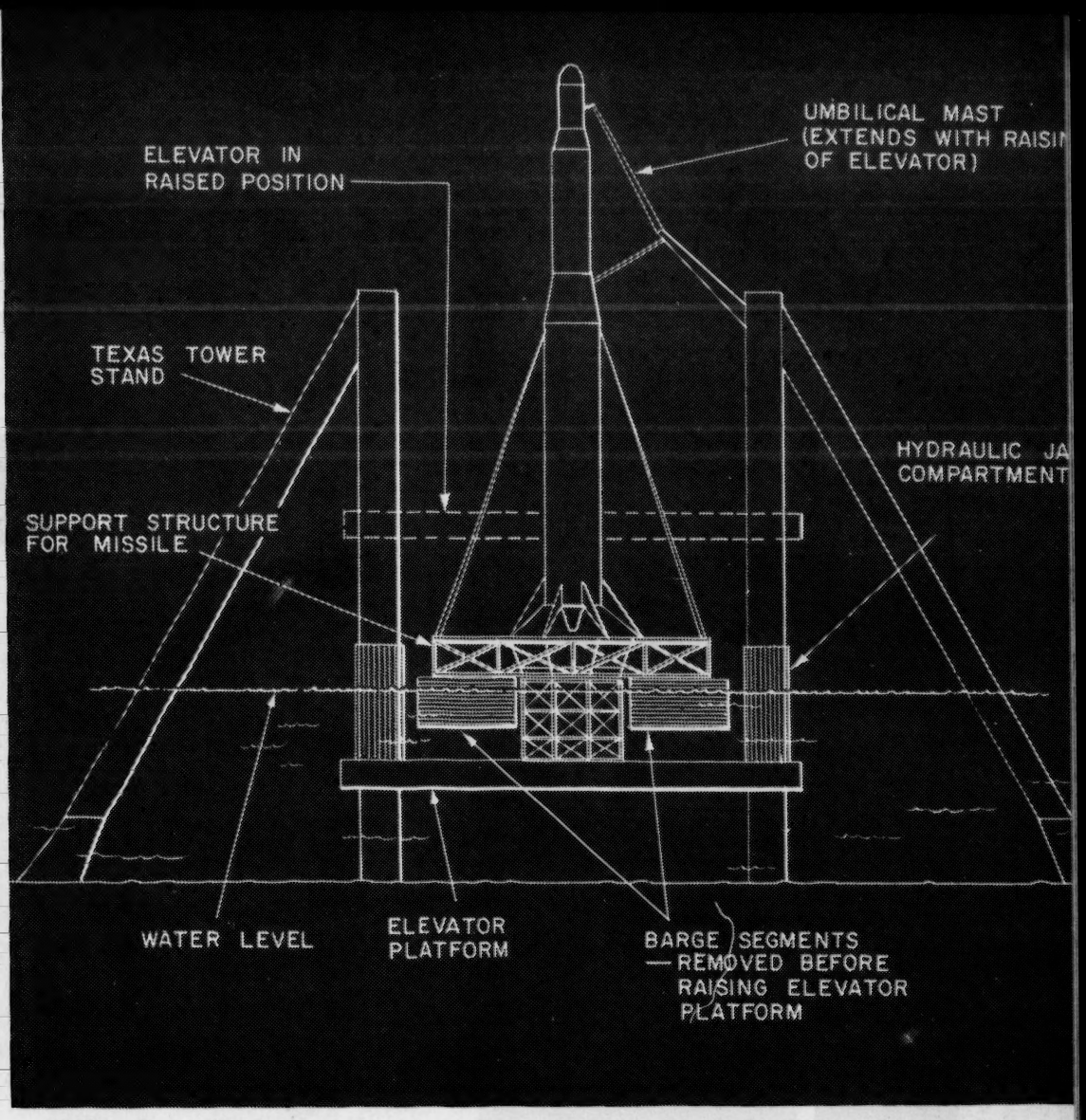
Items being studied include:

- **Family of solid-** and liquid-propellant stage combinations with capabilities up to nearly 4 million lb. thrust. Extensions of this boost capability to 6 million lb. thrust also may be considered, with payload capacity correspondingly larger than 50 tons.
- **All-liquid** and all-solid propellant boosters.
- **Booster recovery techniques** and economics.
- **Land-based** on-the-surface sites and fixed and mobile Texas tower-type offshore pads.
- **Associated booster assembly buildings** with bays almost 300-ft. high to accommodate huge integrated boosters assembled in the vertical position.
- **Systems of trackage** and transport tables, and canals, locks and barges, for conveying erected boosters from assembly buildings to launch sites.
- **Special and conventional** launch control schemes.
- **Booster manufacturing** and propellant loading alternatives, transportation and handling aspects.

The research and development portion of the program, targeted to begin not later than the middle of 1962, is seen extending to 1965. The subse-



HUGE booster considered under all-liquid propellant configurations in Project Phoenix analysis would weigh between 55,000 lb. and 60,000 lb. empty.



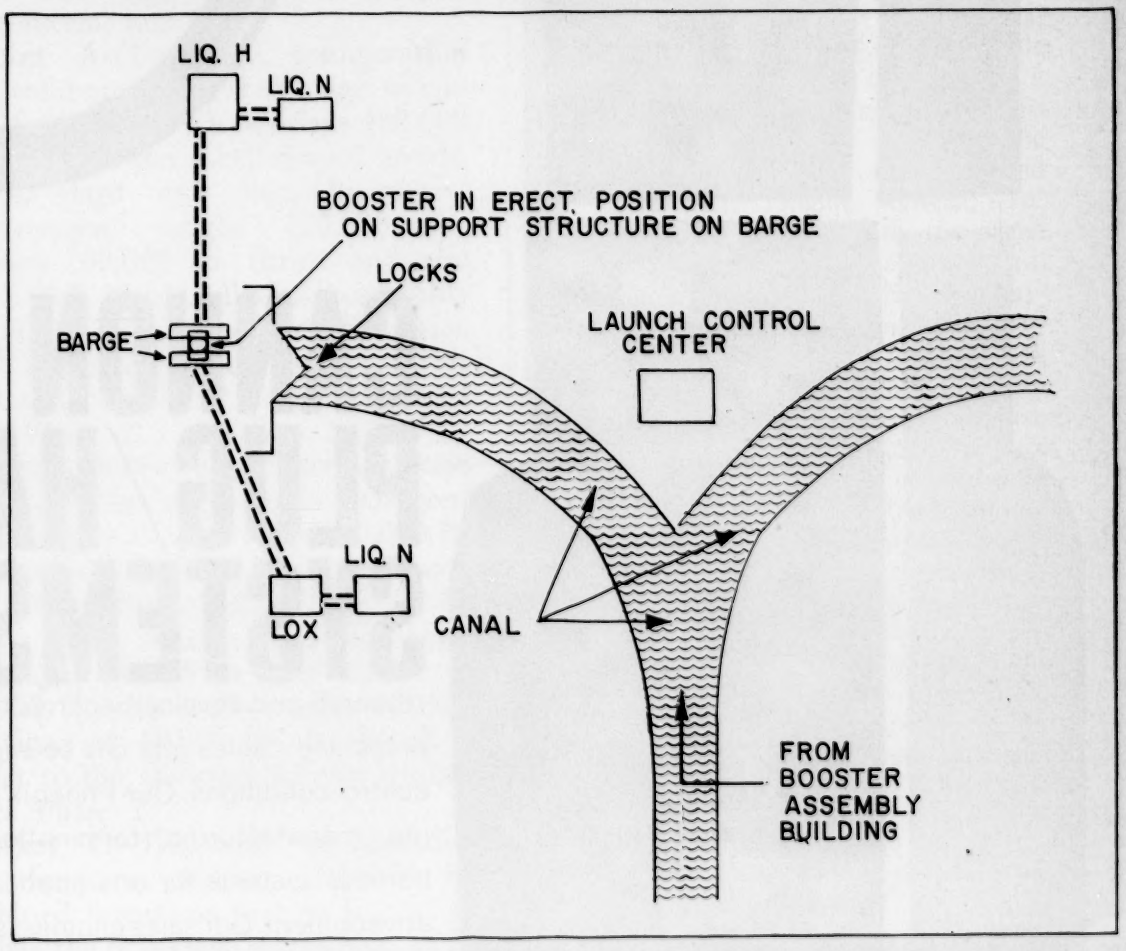
FIXED Texas tower-type launch pad would be serviced by catamaran-type barge. After barge is removed, elevator would raise boosters to firing height—about 60 ft. above water. For servicing water-based site, booster would be transported through canals from assembly building (below). Propellant-loading system would be carried on barges to launch site for booster refueling.

Space Probes

quent 10-year period to 1975 may encompass as many as 1,065 launches—of which approximately 400 would be for operational-type space vehicles.

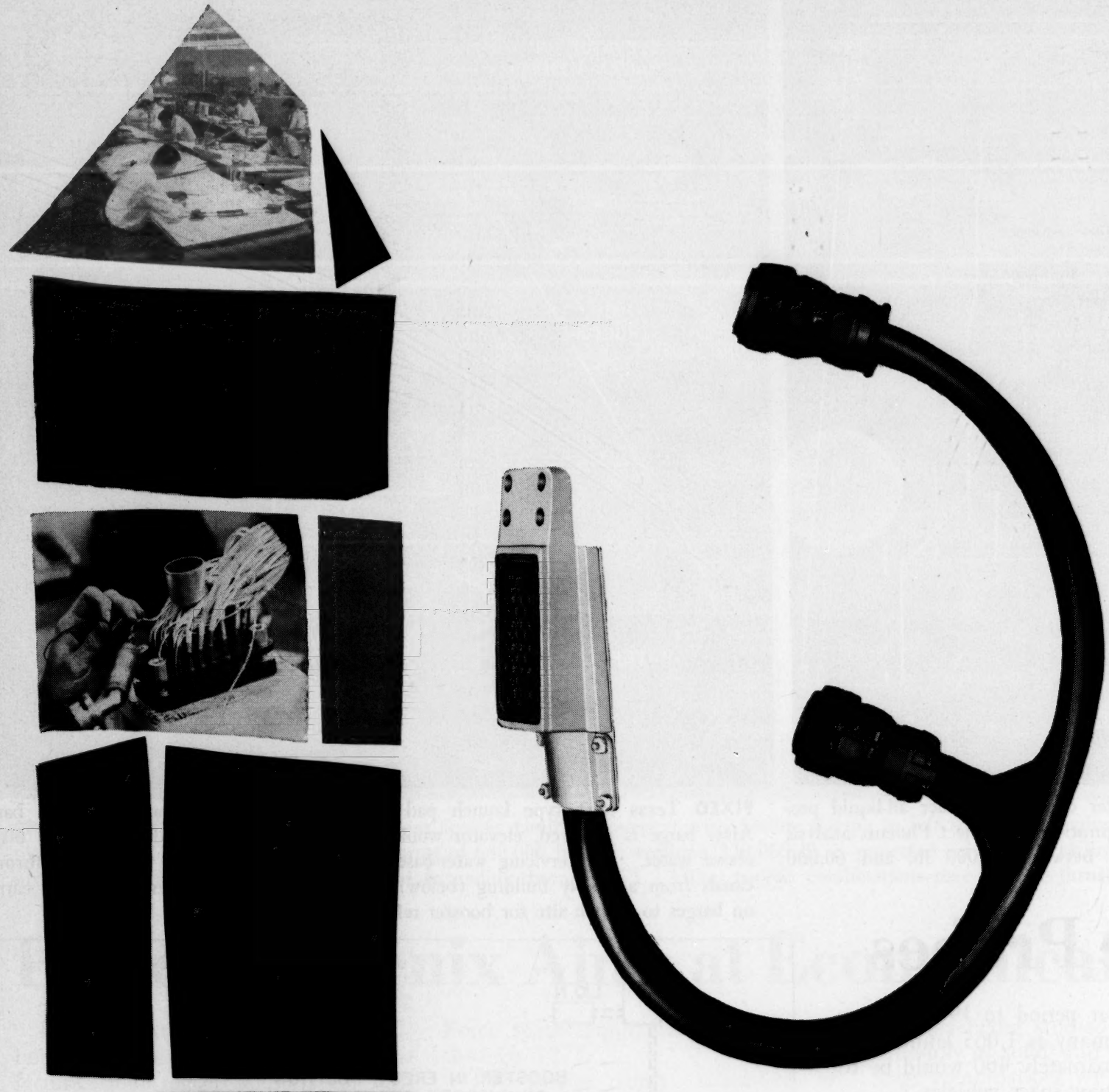
Launch site projections contemplate first installation at Cape Canaveral for the Atlantic Missile Range, then for the Pacific Missile Range, and possibly at a Hawaiian base for both east-west and north-south trajectories.

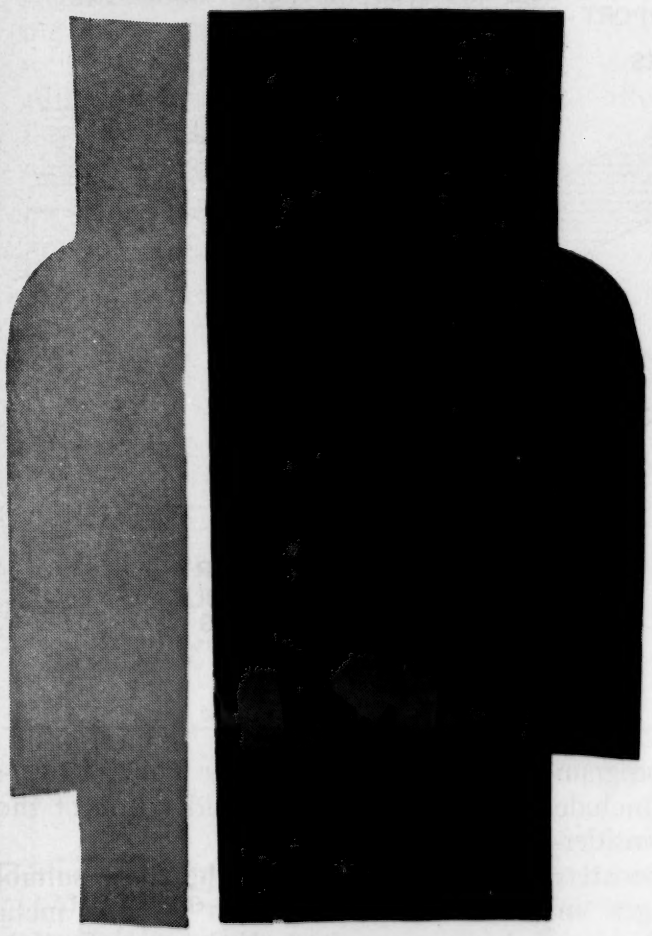
Project Phoenix presentations were made early in January to Headquarters, USAF and Headquarters, ARDC, by personnel from the Ballistic Missile Division as the cognizant military agency; Aerospace Corp., its nonprofit technical-support arm, which is establishing the Phoenix concept and design parameters; and the nonprofit Rand Corp., which is analyzing the economics of Phoenix, aimed at slashing booster-payload costs from a present-day round figure of $1,000 a pound to a target price of about $100 a pound (AW Dec. 19, p. 37).



At the time of these Phoenix briefings, the original approach to the program, comprising a single phase, had been completed. This encompassed booster comparisons of all-liquid systems versus all-solid propellant stages, which was resolved in favor of the all-liquid boost vehicle. The program analysis then was extended to include a second phase which is now considering various configurations of boosters with solid-propellant base stages in combination with liquid-hydrogen/liquid-oxygen upper stages, as well as all-liquid systems. The Phase 1 over-all analysis involved consideration of these highlights:

• **Determination of the most suitable,** minimized-cost launch systems, including aspects of standardization, flexibility for adaptation to various booster con-





CANNON PLUG/HARNESS SYSTEMS

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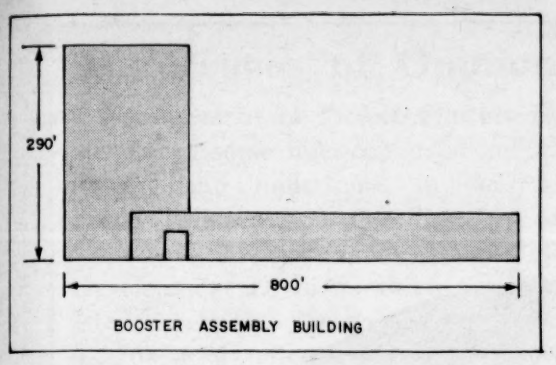
CANNON ELECTRIC COMPANY, 3208 Humboldt Street, Los Angeles 31, California

CANNON PLUGS



BOOSTER assembly building would have very high bay to permit vertical assembly and checkout.

figurations, and use-repeatability, with the same facilities serving for both R & D and operational phases.

• **Definition** of the applied research and development that will be involved.

• **Feasibility** of booster recovery, which included analysis of six possible techniques, including flexible-wing recovery, air snatch with supplemental helicopter participation for delivery to base, and use of retrorockets and chute on booster for slowdown prior to impact and subsequent recovery from the water. Indications are that analysis has revealed that recovery systems would be only "marginal" in effect—that savings would be "modest" at best, not likely to exceed 15%. Arguments against recovery include resulting extensive impact damage and effects on booster materials of high temperature combined with immersion in the ocean. Another indication that booster recovery may not be supported is that it is not being considered in relation to the Phase 2 family of vehicles.

• **Establishment of boost vehicle** sizes and configurations. In this Ballistic Missile Division/Aerospace/Rand analysis under Phase 1, seven industry members assisted with recommendations for booster schemes. Ten boost plans were considered ultimately, most being all-liquid-propellant combinations. One of the very few all-solid configurations was a four-stage arrangement with a cluster of seven segments as the first stage, seven as the second stage, and clusters of three segments for the third and fourth stages.

Details of one of the most promising liquid-propellant configurations considered under Phase 1 indicate the magnitude of the design and operational problems involved in Project Phoenix. This two-stage rocket would use liquid-hydrogen/liquid-oxygen as the propellant and would be pump-fed because a pressure-fed installation probably would be too heavy. Stage 1 would develop approximately 800,000 lb. thrust and, supplemented by Stage 2, would be capable of putting a 25-ton payload into space.. Stage 1 would be fitted with a plug nozzle; the upper stage would have a conventional bell nozzle.

The configuration would have a length, without payload, of more than 180 ft., maximum body diameter of approximately 20 ft., widening at the skirt to about 23 ft., and extending to approximately 35-ft. diameter at the vernier rocket area. Total weight empty would be between 55,000 and 60,000 lb.

On a land-based pad it would stand about 70 ft. above the bottom of the fire pit and would require a 290-ft.-high gantry supported on a rail truck measuring 100 ft. x 125 ft. A monorail hoist would be located at the 270-ft. level of the gantry.

As a separate input under Phase 1, the general position of nuclear rockets of the Rover type and the Orion successive-explosion type were considered but could not be included because of the time required for development and subsequent test effort.

At the end of Phase 2, which is an extension of Phase 1, detailed presentations will again be made to USAF and ARDC Headquarters and the program will be implemented. One of the most promising groups of solid- and liquid-propellant combinations studied under Phase 2 affords a high degree of flexibility through utilization of interchangeable staging for achieving payload capabilities ranging from 15,000 to 93,000 lb.

Details of this family of rockets, which also includes one all-liquid configuration, are:

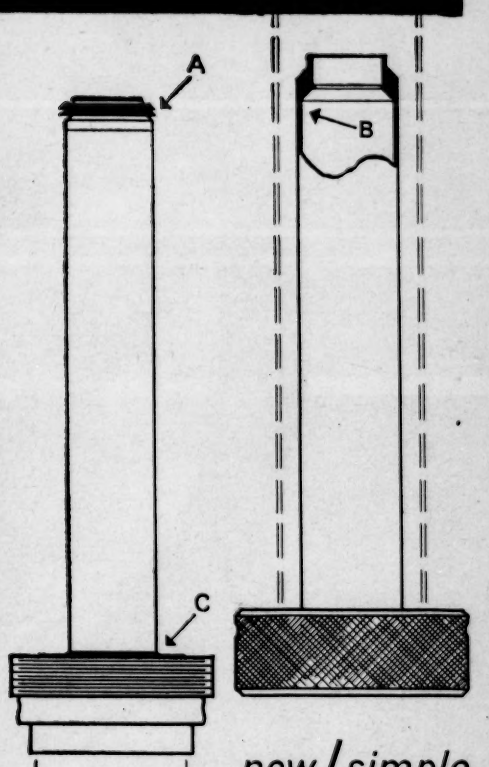
• **Rocket A**—Two-stage configuration has a solid-propellant first stage weighing 110,000 lb. which develops 480,000 lb. thrust and uses a bell-shaped nozzle. Second stage uses liquid-hydrogen/liquid-oxygen, weighs 120,000 lb., develops 200,000 lb. thrust and also uses a bell nozzle. Payload capability is 15,000 lb. This specific configuration probably would be the most extensively used in this family of rockets projected under Phase 2.

• **Rocket B**—Two-stage configuration has a first stage using liquid-hydrogen/liquid oxygen which weighs 400,000 lb. and develops 700,000 lb. thrust with plug nozzle. Second stage (200,000 lb. thrust), is the same as the second stage on Rocket A. With total thrust of 900,000 lb., this configuration will loft a payload of 40,000 lb. Rocket B is similar to the all-liquid booster studied under Phase 1.

• **Rocket C**—Two-stage configuration uses the same staging (900,000 lb. combined thrust) as that on Rocket B, but has the first stage augmented at its base by a cluster of solid-propellant rockets weighing 110,000 lb. and developing 750,000 lb. additional thrust. This configuration (1.65 million lb. total thrust) permits a payload of 55,000 lb. to be boosted.

• **Rocket D**—Two-stage configuration

CRYOGENICS



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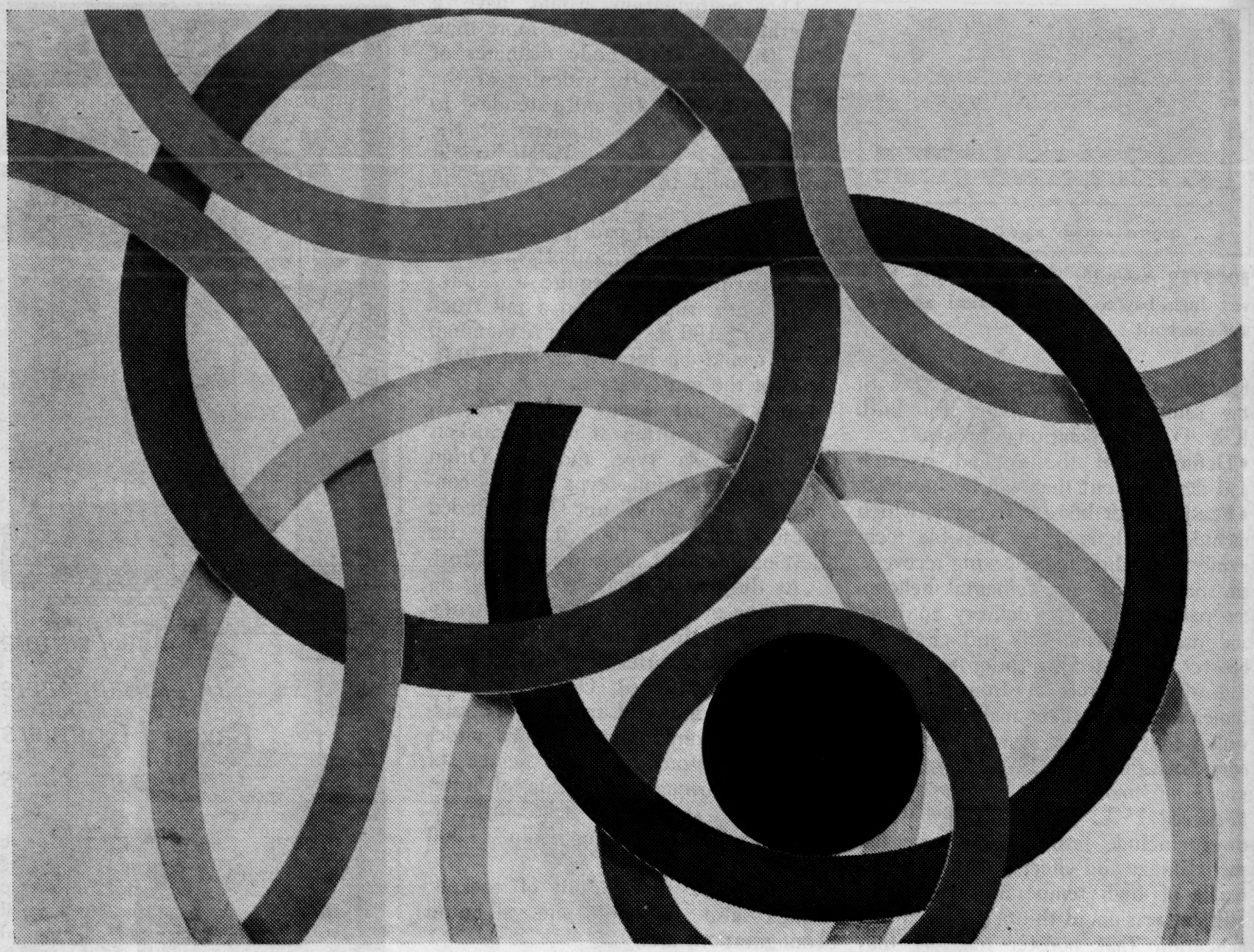

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Differences of Opinion

Advancement of Project Phoenix has introduced some inter-command and intra-command undertones in the Air Force. Elements in the Strategic Air Command, as well as in Wright Air Development Division, which are interested in Space Plane (AW Oct. 31, p. 26) as a potential hydrogen-fueled, oxygen-scooping-and-liquefying vehicle for carrying large payloads into space, have indicated that this surface-to-altitude hauler might possibly reduce booster-payload costs to as low as $50 a pound.

The Phoenix system has the edge in time, it is admitted, since potential powerplants for Space Plane—the liquid air cycle engine (LACE) on which Marquardt is working or Pratt & Whitney's high-pressure engine—probably could not be flight-tested before 1969.

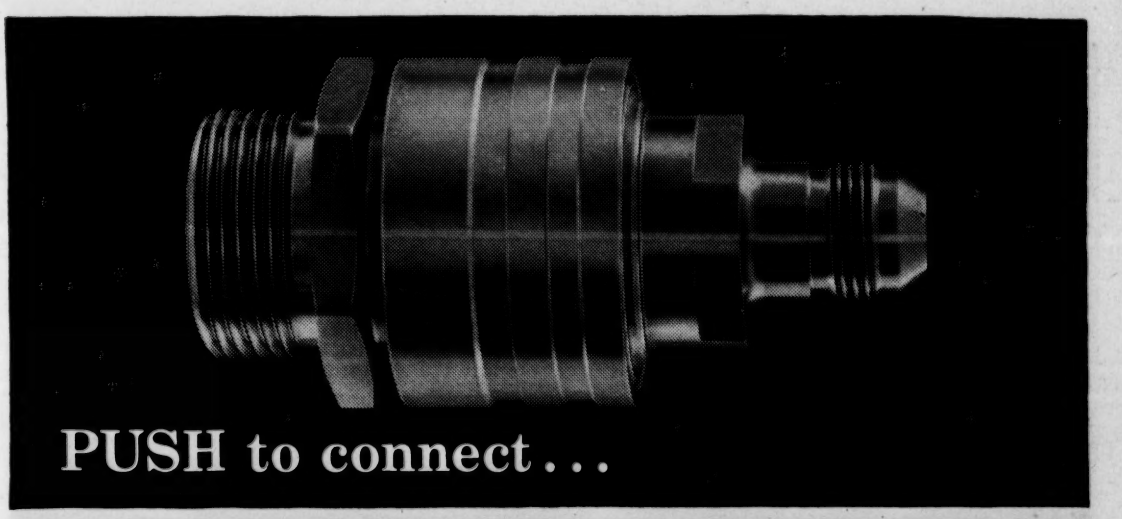
has a first stage composed of a cluster of solid-propellant rockets weighing 500,000 lb. and developing 2 million lb. thrust, using bell nozzles. Second stage (700,000 lb. thrust) is the same as the liquid-hydrogen/liquid-oxygen first stage on Rockets B and C. With total thrust of 2.7 million lb., this configuration will lift a 63,000-lb. payload.

• **Rocket E**—Three-stage configuration has a first stage composed of a cluster of solid-propellant rockets weighing 400,000 lb. and developing 3 million lb. thrust, using bell nozzles. Second stage (700,000 lb. thrust) is the same as the liquid-hydrogen/liquid-oxygen first stages on Rockets B and C and the second stage on Rocket D. The third stage (200,000 lb. thrust) on Rocket E is the same as the liquid-hydrogen/liquid-oxygen second stages on Rockets A, B and C. Developing a total thrust of 3.9 million lb., Rocket E will boost 93,000 lb. into space.

Since a prime objective of the Phoenix study is to establish the most economical launching system for military space vehicles, cost analysis includes the interplay of all factors involved in the range of tasks from the end result of launching through all the phases down to manufacturing alternatives, and tradeoffs must be weighed in arriving at a favorable balance between economy and efficiency.

Under consideration is a launch complex using a pad of standard configuration, with a gantry to erect the staging for mating into an integrated booster and space vehicle (payload). The gantry could be eliminated if the booster were mated and erected elsewhere, then transported in vertical position to the site.

Both fixed and mobile types of Texas tower launch pads are being studied for deployment in open water. The Texas



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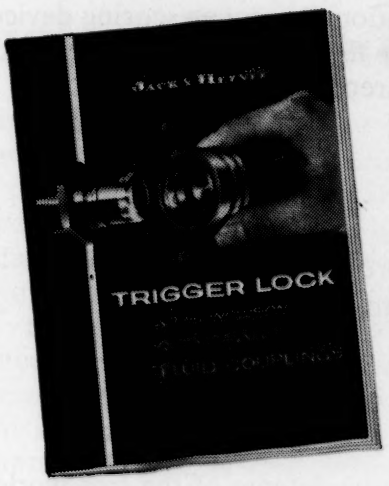

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tower type launch pad is considered feasible to reduce congestion at a land-based complex such as Cape Canaveral. It also minimizes hazard and damage in the event of booster blow-up on the pad, which, if the booster were very large, as in the case of Phoenix, conceivably could destroy not only its own pad but adjacent pads and installations.

The fixed-type Texas tower would rest on concrete piers and would have an elevator platform below water to allow the flotation above it of a catamaran-type barge which supports the erected booster on a table structure. The barge would be removed before the Texas tower pad's elevator platform raises the booster to the firing height so the nozzle is about 60 ft. above water. The umbilical mast, which is part of the Texas tower equipment, would extend as the booster is elevated to firing height.

The propellant loading system for a liquid-fueled booster could be carried on barges which would be towed to the Texas tower launch pad.

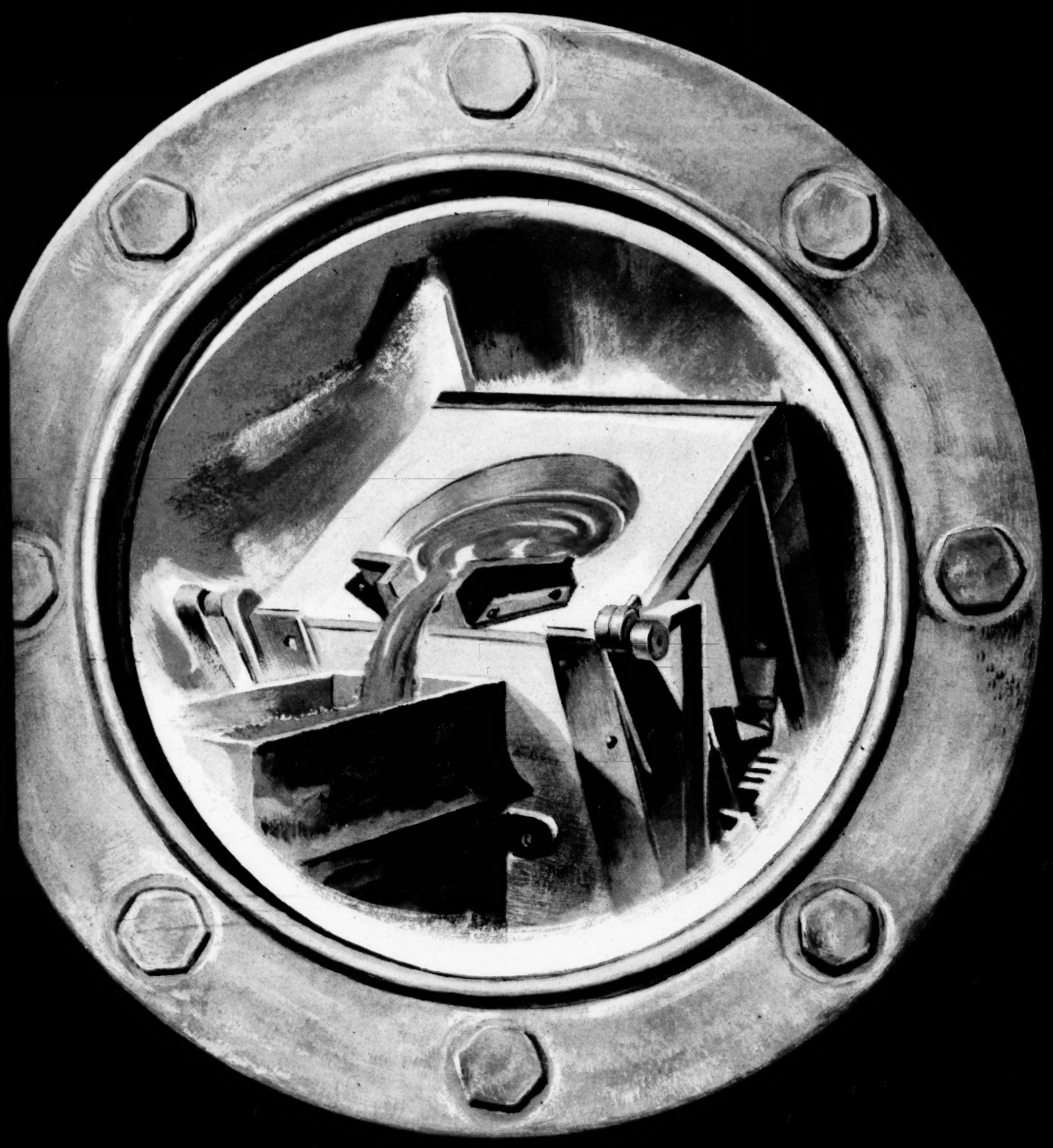
For the conventional launch pad configuration, a control blockhouse of the type being used for the Titan ICBM is being considered. Probably this same type of control center also would be used for a Texas tower launch pad located less than 1,000 ft. from the shore. Cabling from the control center to the pad would be carried on a pier or through an underwater conduit. For a Texas tower pad beyond the 1,000-ft. distance, the control center could be located on a barge, with connecting cabling resting on floating supports or carried in a submerged conduit.

Manufacture of booster stages at existing facilities and shipment of the stages to the launch site for checkout of each stage and mating would involve more ground support equipment at the pad than if a booster assembly building at the site were used for stage checkout and mating.

If individual-stage and mated-booster checkout is made in a horizontal position in the booster assembly building, with erection and final checkout at the launch pad, only a relatively low assembly building would be required, but erecting mechanism and a service tower would be required at the launch pad. The assembly building also could be used for assembly and checkout of the payload.

Checkout and mating of the booster in the vertical position at the booster assembly building would require a very high bay and transportation facilities to the launch site. No gantry would be required at the site, since the umbilical tower could afford approach to the rocket for emergency service.

Complete manufacture of the



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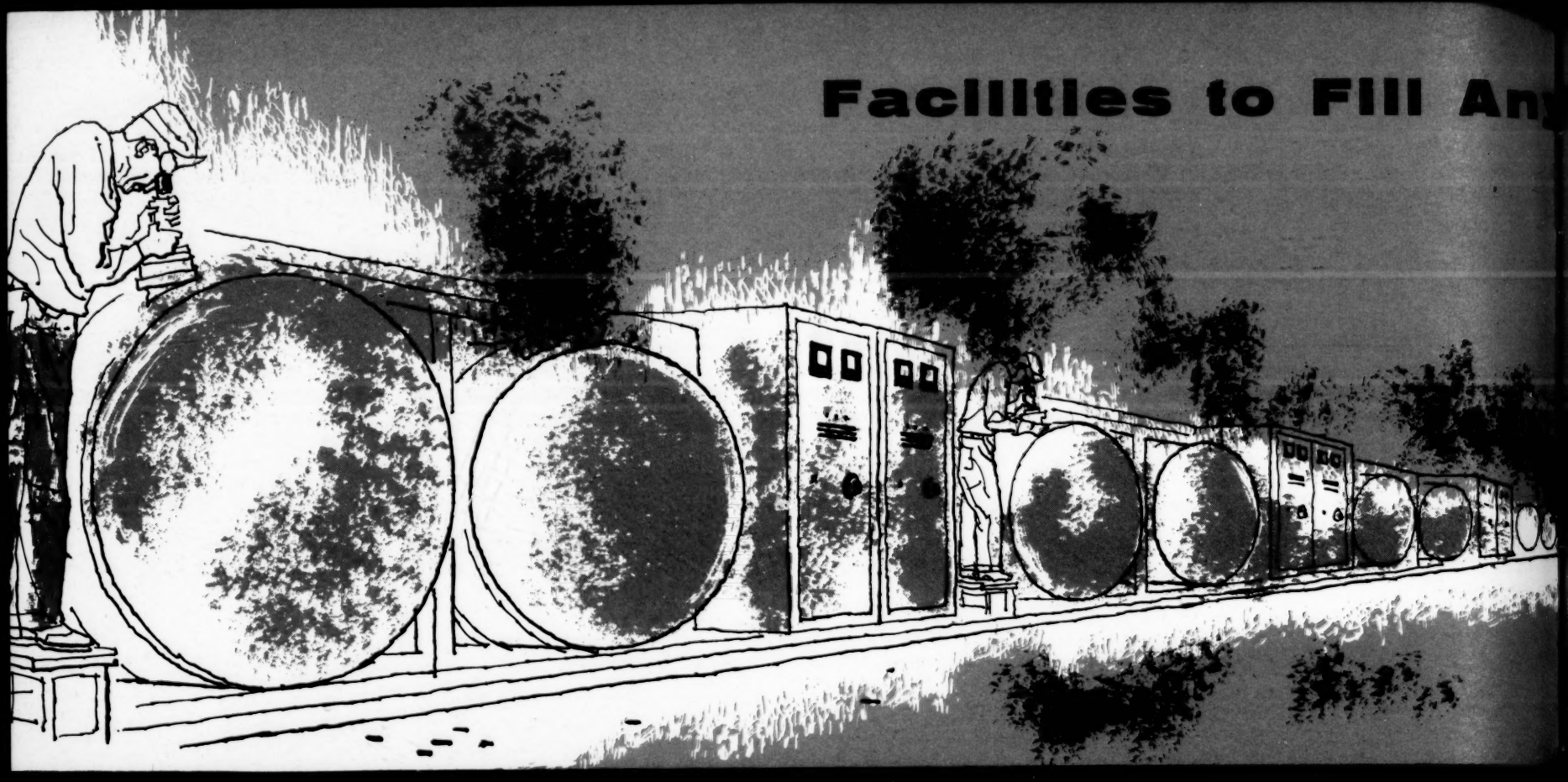
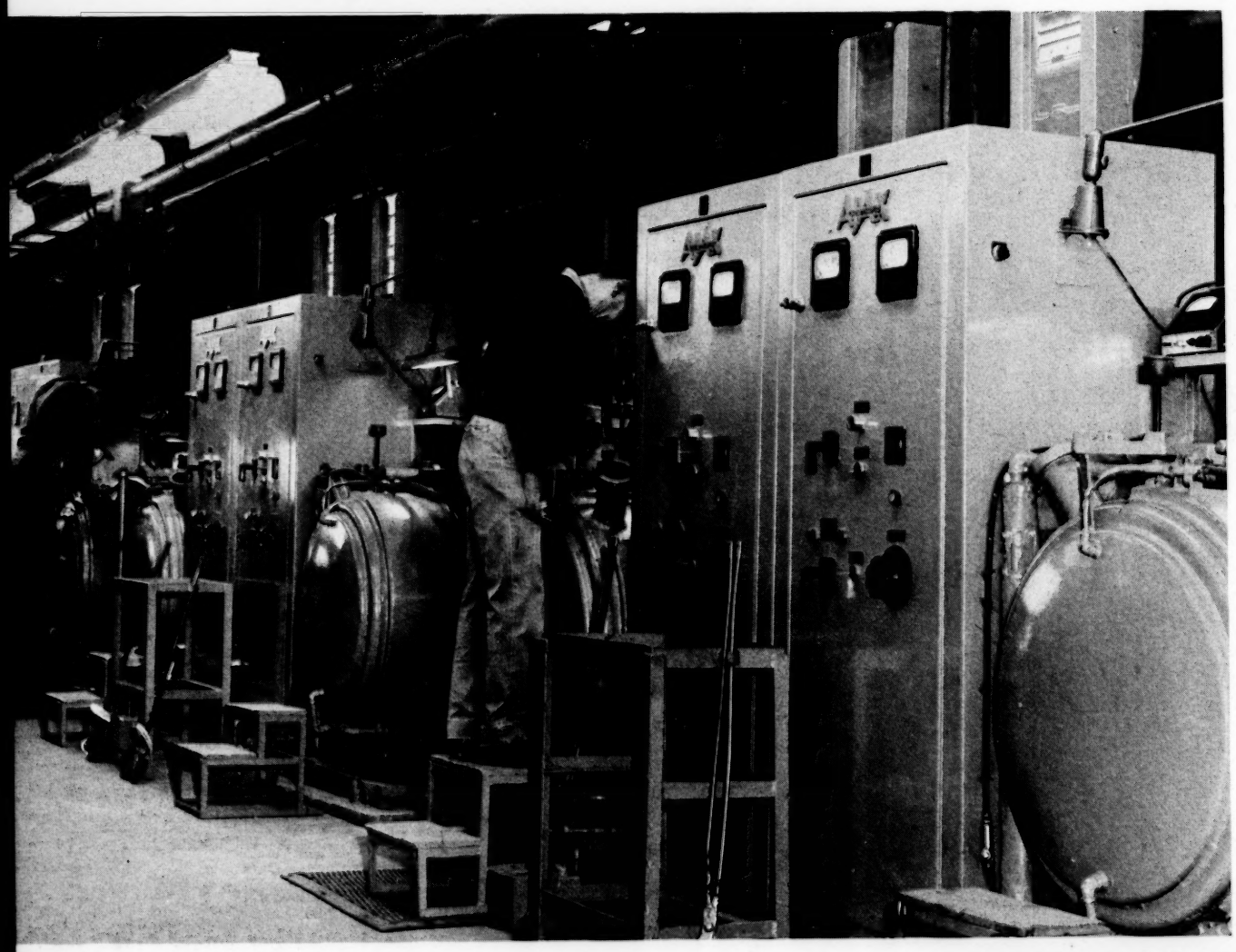
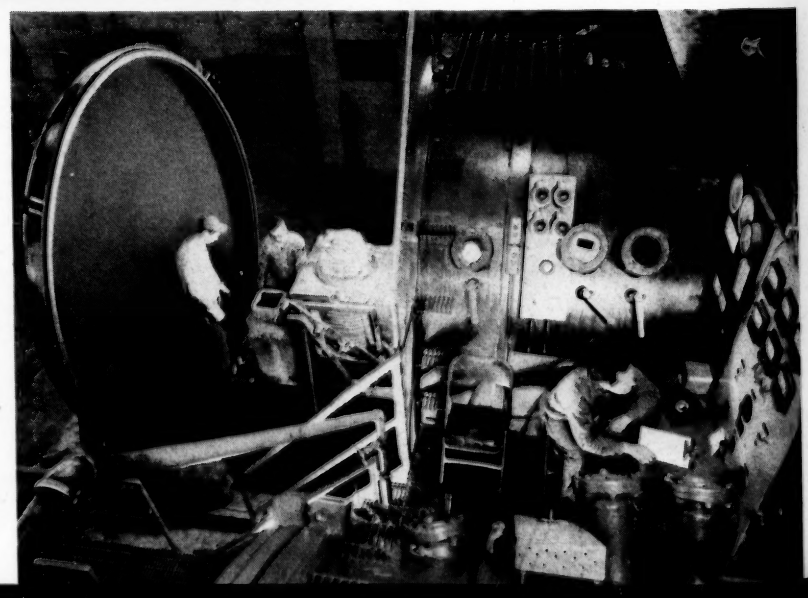




17-Lb. Furnaces–Investment castings are poured, under vacuum, in about 20 minutes in one of these special furnaces. Solid bars of vacuum-melted master alloys are remelted in the enclosed chamber and poured into molds. There are six furnaces similar to the ones pictured here, each with a capacity for melting 17 lb. of alloy. Pouring takes place automatically under a vacuum of less than 10 microns.

1500-Lb. Vacuum Induction Furnaces — Vacuum-casting alloys are first melted and refined at Haynes Stellite Company in one of these 1500-lb. induction furnaces. In all, there are 300,000 pounds per month of primary vacuum-melting capacity. The furnaces are enclosed in shells eight ft. long and 12 ft. in diameter. High vacuums are held in the chambers during critical refining stages and when oxidizable alloys are added.



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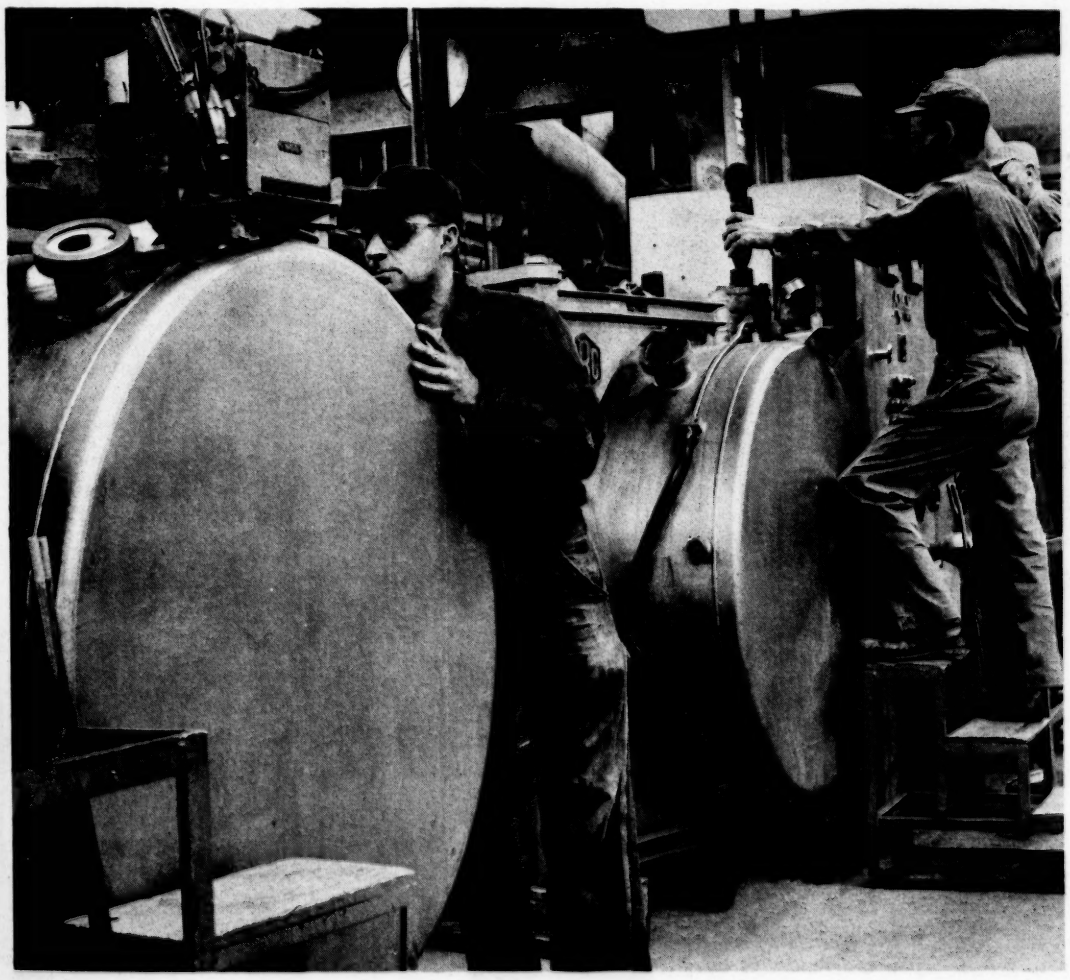
acuum Casting Requirement

To-date, Haynes Stellite Company has produced over 350,000 parts by vacuum melting and casting. These have been produced in the alloys listed on the following page as well as in many other developmental alloys.

Haynes Stellite Company's experience with vacuum-melting of alloys goes back to some of the original work done by Union Carbide in the early thirties. Today there are three melting and refining furnaces and 12 remelting and casting units. All are equipped to operate under vacuums of just a few microns.

These facilities are available for the production of any vacuum-casting alloy. For more information, contact one of the Company offices listed on the following page.



30-Lb. Furnaces—Each of these furnaces can remelt a 30-lb. charge of master alloy and pour one or more investment castings under a vacuum. There are six, 30-lb. furnaces in addition to the 17-lb. ones pictured at left. Present production capacity is more than two tons of high-grade, vacuum-poured alloy castings per day made from vacuum-melted master heats.

Inert-Atmosphere Casting—In addition to vacuum-casting facilities, special induction furnaces are also available for pouring under pressure and in an inert-gas atmosphere. Each of these ten furnaces remelts and pours from eight to ten pounds of alloy at a time.

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	Approximate Chemical Composition, per cent								
	Nickel	Chromium	Iron	Carbon	Boron	Molyb-denum	Aluminum	Titanium	Others
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HASTELLOY Alloy 700	Bal.	14.5	0.8	0.07	0.01	5.0	4.5	3.5	Co=17.00 Zr=0.01
HAYNES Alloy No. R-41	Bal.	18.0-20.0	5.0**	0.06-0.12	0.003**	9.0-10.5	1.5-1.8	3.0-3.3	Co=10.0-12.0
HAYNES Alloy No. 294	Bal.	15.0	—	0.02	0.07	5.0	6.7	—	Zr=0.10
HAYNES Alloy No. 713C	Bal.	12.0-14.0	2.5**	0.08-0.20	0.005-0.015	3.5-5.2	5.5-6.5	0.5-1.0	Co=1.0** Zr=0.05-0.15 Cb+Ta=1.8-2
GMR-235[1]	Bal.	14.0-17.0	8.0-12.0	0.10-0.20	0.05-0.10	4.5-6.0	2.5-3.5	1.5-2.5	—
GMR-235D[1]	Bal.	14.0-17.0	3.5-5.0	0.10-0.20	0.05-0.10	4.5-6.0	3.25-4.0*	2.0-3.0*	—
SEL[2] Alloy	Bal.	14.0-16.0	1.0**	0.05-0.11	0.01-0.02	4.0-5.0	4.00-4.75	2.00-2.75	Co=26.00-28. Cu=0.10**
WASPALOY[3]	Bal.	18.0-21.0	2.0**	0.05-0.10	0.002-0.008	3.5-5.0	1.0-1.5	2.75-3.25	Co=12.0-15.0 Zr=0.05-0.12 Cu=0.10**

*Al+Ti=5.6-6.5
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booster at the launch site could eliminate the need for a booster assembly building there, and would also eliminate the need for transportation over great distances of large individual or mated stages. Transportation of assembled boosters from an on-site factory to the launch pad would be similar to the requirements introduced with use of a booster assembly building receiving stages from off-site (existing) manufacturing facilities.

Maximum-size boosters envisioned under Project Phoenix could be transported between existing manufacturing facilities and launch site if adequate transport access were available from the facility to the loading point and from the unloading point to the launch site. Special barges could be constructed to accommodate the large boosters. Craft of the LST (landing ship, tank) type could accommodate boosters with diameters up to 50 ft., and LSD (landing ship, dock) type craft could handle boosters up to 30 ft. in diameter.

For transport from the on-site booster assembly building or the on-site manufacturing building, the erected mated stages (integrated booster) could be supported on a transport table or car rolling on tracks to a land-based launch site, or carried erect on a barge to a water launch site.

If the booster stages were transported horizontally from the on-site booster assembly building or on-site manufacturing facility, they could be carried by rail, barge or by highway.

UNUSUAL photograph of meteor (at left) burning in the earth's atmosphere was taken, with instantaneous exposure, by new General Electric optical tracking system.

Optical Space-Shot Tracker Tested

Combination of a high-power telescope and high-sensitivity television camera tube is under development by General Electric Co.'s General Engineering Laboratory for optical tracking of space probes.

Based on early results of tracking experiments, one engineer indicated that visual tracking of moon probes to impact or orbit was possible.

The visual tracker is intended to complement other tracking devices such as radio telescopes. Obviously a visual system is ineffective if there is a cloud cover. But the new system offers the advantage of being able to track a space probe or satellite if the vehicle's transmitters are not functioning.

One indication of the sensitivity of the new system is that it was used to take movies, not time-lapse exposures, of the northern lights recently. The tube can photograph objects in the normal landscape around it at night, solely by starlight.

Other projects under study as applications of the new tracking system include detection of space objects in daylight, countering optical interference of the aurora borealis, high-resolution scanning of planets and other natural space objects, identification of space vehicles by spectral analysis and battlefield surveillance.

The tracker is part of General Electric's privately funded radio-optical observatory near Schenectady, N. Y. Work of the observatory includes general studies of space communications and related tracking problems.

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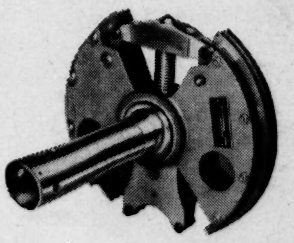

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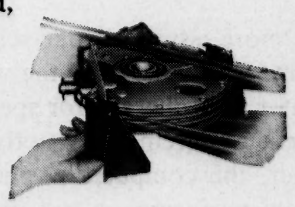

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The more advanced our scientific ventures into space become, and the more sophisticated the weapons in our defense arsenal grow, the greater need there is for special purpose computers engineered to fit system requirements exactly. Serving as the nerve and intelligence center, the computer is playing an increasingly important role in system performance and reliability.

A prime Sperry capability is computer technology—both digital and analog. In the analog field, the B-58 bombing-navigation computer is outstanding. Airborne digital applications include a countermeasures computer which sorts out the enemy's "confusion" data, decides *logically* the best means of counteracting it. Another is a subminiaturized, radiation resistant, ultra-reliable computer for missile guidance. In component technology, Sperry memory drums, most advanced in the field, include an air-bearing floated-head type with extremely long life and high storage capacity. Other advanced techniques are incorporated in studies and designs for the future . . . for computers applicable to space vehicles.

On the surface, a small digital computer for ground support equipment checks out a complete airborne reconnaissance system. This "building block" computer is unique in its universal adaptability for reprogramming.

On the Polaris submarines, a digital "brain" collates, analyzes, decodes and distributes the widest variety of navigational data ever centered in a single operation. In an anti-submarine warfare program, a high speed digital computer accepts, operates on, stores and displays instantaneous data relating to the target under consideration.

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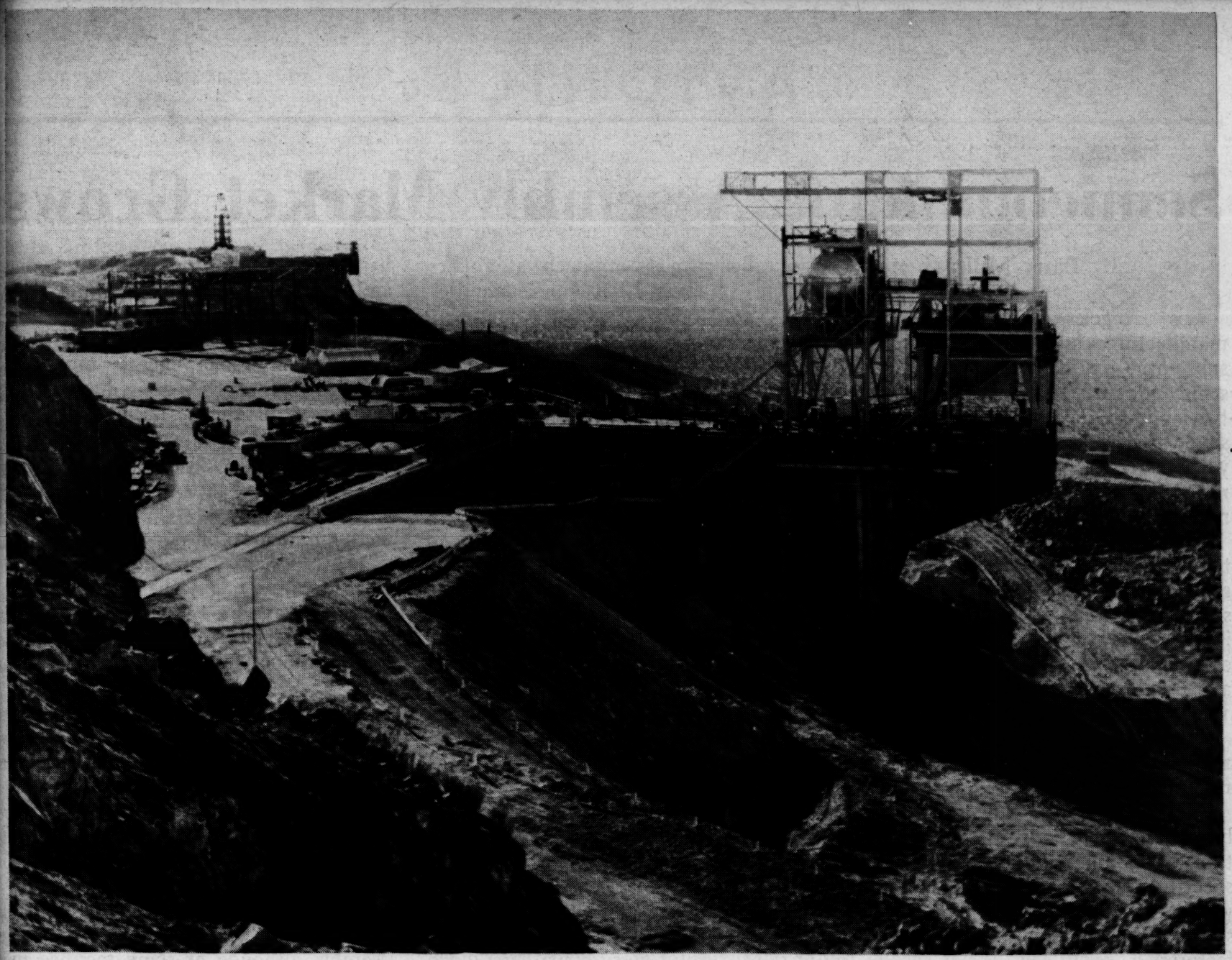
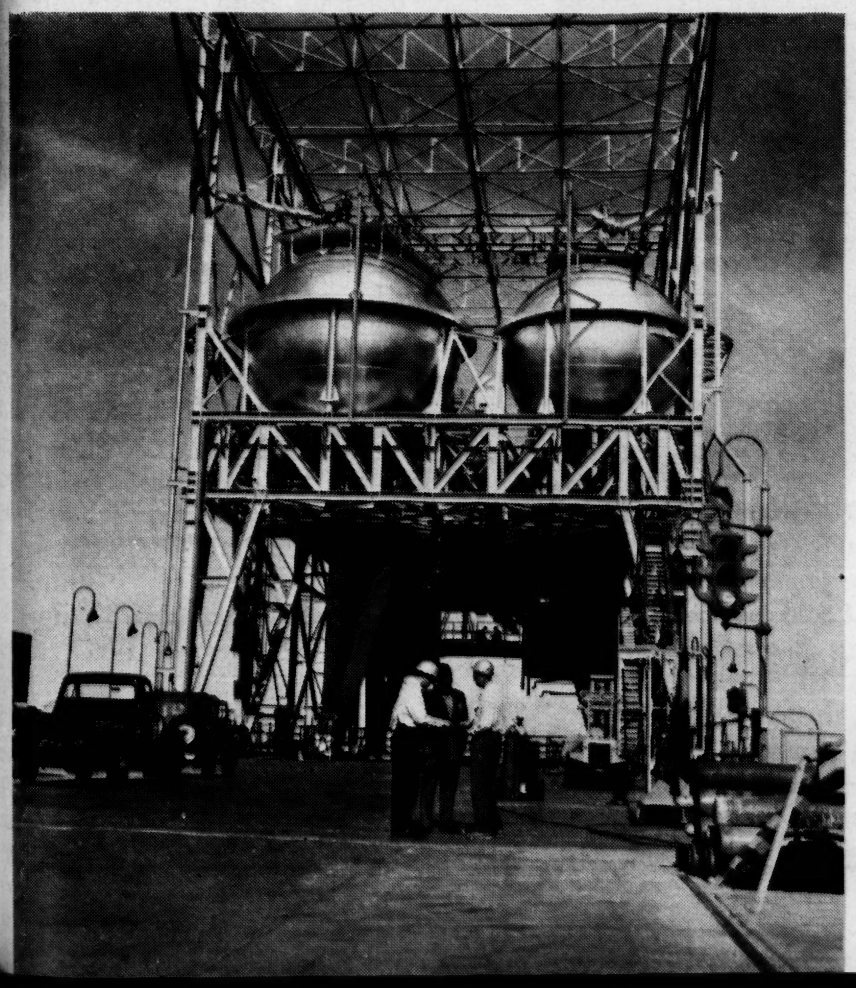
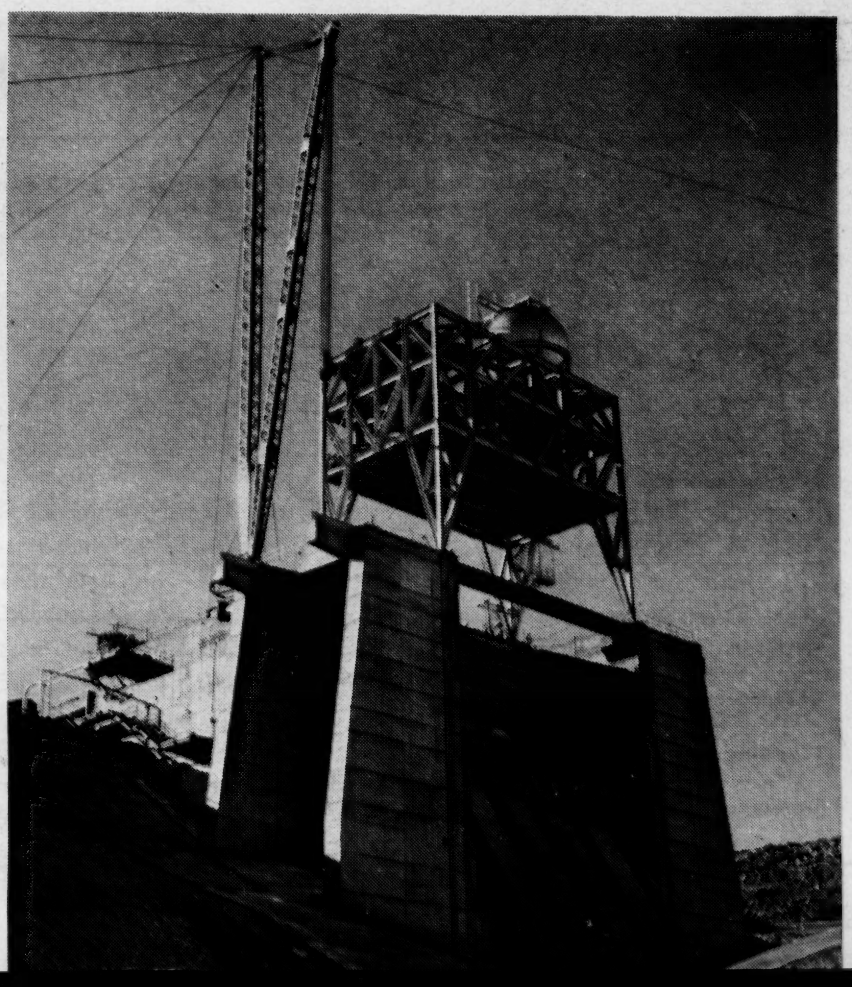


Test stand 1A at Rocket Engine Test Station, Edwards AFB, Calif., is virtually complete. It needs only instrumentation and engine installation. Stand 1B (shown below, right) and stand 2A (not shown) complete Rocketdyne test complex.

F-1 Rocket Testing Complex Nearing Completion

Test stand 1A is at left. Construction of stand 1B (right) for static firings of large boosters is nearing completion. The largest structure of its kind in the western world, it contains two test positions and is 230-ft. high. It is scheduled to be completed this summer and will be used to test NASA's 1.5-million-lb.-thrust F-1 Rocketdyne booster.





Semiconductor Assembly Market Grows

By Barry Miller

Los Angeles—Avionic component manufacturers are looking forward to a substantial rise in the market for special semiconductor assemblies—groups of two or more separate components in a single package—during the next several years, a recent AVIATION WEEK survey reveals. These are specially suited for missile and space applications.

Starting as a custom operation intended to handle individual requests for special groupings of components, the special assemblies business has matured in only a few short years to what several survey participants estimate will be a $10-million to $20-million market in 1961.

During the next four years, this market is expected to increase annually, reaching about $100 million in 1965.

To a great degree, the special assemblies business remains a custom operation. The dominant share of present special assemblies is supplied on individual request and made to individual specifications by semiconductor manufacturers.

But the balance is beginning to tip toward standard lines of special assembly products. A number of semiconductor device makers, including Fairchild, Hughes, Pacific Semiconductors, Texas Instruments and Transitron, now offer as part of their regular product lines specific groupings of basic components in stable mechanical enclosures. These are called special component assemblies. Some companies are making single packages containing separate components connected in actual circuits—referred to as special circuit assemblies to distinguish them from component assemblies. Both assembly types are made by roughly the same techniques.

Usually a special assembly consists of groupings of individually encapsulated components. The latter may be any of the various generations of component sizes—miniature, subminiature or microminiature. Component leads generally are welded together; the entire assembly is then encapsulated into a mechanically stable and environmentally resistant package. The assembly then looks like and can be treated as another component.

Typical Assemblies

Typical component assemblies might contain electrically identical components to be used where matched temperature or electrical characteristics are required. Such assemblies could comprise matched pairs or triads of diodes or transistors, or possibly matched diode quads for bridge or modulator applications.

Normally, without special assemblies, the process of selecting components for circuit applications which demand selected or matched electrical characteristics is a time-consuming and costly task for the systems designer. Components must pass through many hands, through numerous cataloging and testing steps before reaching their final circuit destination. This only heightens the hazard of damage or loss. Often many components must be checked before the desired ones are found. With the assemblies, the designer gets the complete element ready for plug-in, welding or soldering.

The assembly effectively shifts the burden of properly selecting the correctly matched components from the systems designer to the component manufacturers. And the latter, understandably, are in a better position to select matched components from a single production run, at a single station, etc.

Special assemblies may become particularly attractive housings for the new micro components which are appearing in increasing numbers. Because of their very small size, these components require unusually careful handling and special techniques in assembling them into systems. Single packages containing a number of these components in a basic function would ease handling and assembly although at some sacrifice in the micro components' space- and weight-saving potential. Recognizing this, several component makers, Pacific Semiconductors, Rheem and Transitron among them, are readying micro assemblies for this market.

Other advantages of special assemblies include:

• **Economical component density**—Even

Special Semiconductor Assemblies

Company	Special Component Assembly Product Line	Special Circuit Assembly Product Line	Custom Work on Special Assemblies	Typical Special Assembly Products
Delco Radio		x	x	Potted transistor digital circuit modules (welded modules).
Fairchild	x		x	Planar diode pairs and quads; twin-planar transistors.
General Electric		x	x	Transistor logic elements; core-diode magnetic shift registers.
Hughes	x		x	Cartridge rectifiers; voltage regulator diodes.
International Rect.	x	x		Reference elements.
Pacific Semiconductor	x	x	x	Bridge rectifiers, modulator quads, high-voltage cartridge rectifiers.
RCA	x	x	x	Twin planar transistor; rectifier stacks.
Raytheon		x		Logic circuits (welded modules).
Rheem Semiconductor	x	x	x	Matched pairs and quads.
Texas Instruments	x		x	High-voltage diode stacks.
Transitron	x	x	x	Plug-in rectifier quads, diode quads; high-voltage rectifiers.

with conventional miniature or subminiature components, component density of a special assembly is relatively high compared with ordinary circuit card techniques because of tight component assembly.

• **Environmental protection**—All components are protected by encapsulating materials. Specifications for most available assemblies claim they will survive extreme missile and space environments.

• **Inventory of components simplified**—Fewer components need be stocked by the system user.

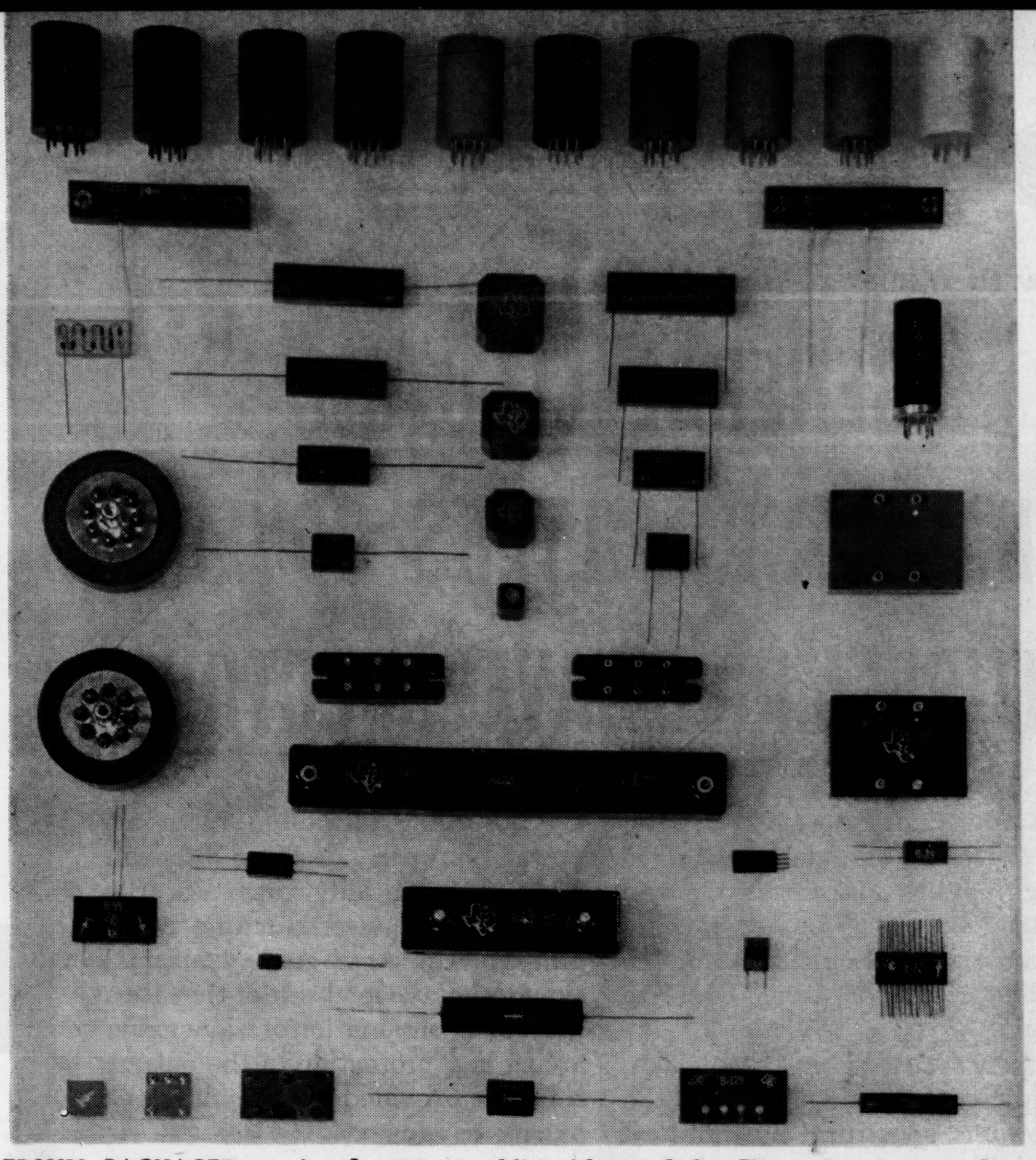
Major disadvantage of the assemblies is that they rob the circuit designer of the flexibility he once had in his designs. With the over-all trend toward functional circuits and molectronics in the years ahead, however, he would not have been able to retain this flexibility for long even in the absence of special assemblies. The cost of assemblies is not low, although this should drop as the market for them expands.

While motivated by the same desire for compactness, reliability and eventual low cost, special assemblies constitute a distinctly different approach in component development from microcircuitry and functional circuit work conducted by many companies, including those in the special assemblies field.

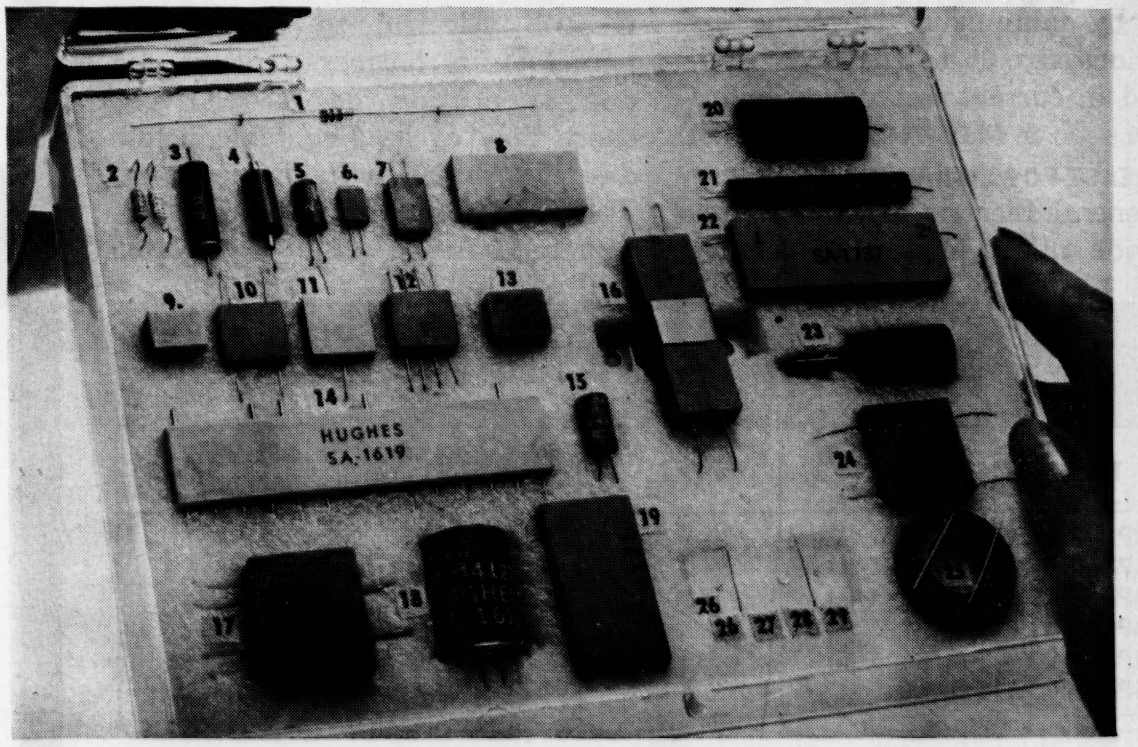
Component manufacturers who indicate they now have special component assemblies available as part of a regular product line include:

• **Fairchild Semiconductor,** Mountain View, Calif.—Twin low-leakage silicon transistors (with collectors common) in five-lead TO-5 cans and two isolated high-gain silicon planar transistors in six-lead TO-5 cases are among devices offered by the Special Products Group set up by this company in December. Also, the company's diode operation sells high-performance, matched planar diodes (pairs and quads) with a guaranteed match from −55 to 100C. The transistors in the five-terminal can provide nearly identical current gains, voltage offsets and thermal characteristics and are suited for use in low-level d.c. and a.c. choppers, analog switching gates and matched amplifiers. The six-lead twin transistor unit is useful in low-drift and low-noise d.c. differential amplifiers where temperatures of two transistors must be alike to minimize differences between devices. For multiple assemblies, special headers were developed to provide electrical isolation of components but to retain thermal proximity.

• **Hughes Semiconductor,** Newport Beach, Calif.—Over a million packaged assemblies encompassing more than 600 standard and special designs have been delivered by this organization to customers during the past couple of years. Presently, it is primarily selling the custom package service (cartridge



EPOXY PACKAGED semiconductor assemblies fabricated by Texas Instruments, Inc., include logic modules (cylindrical packages in top row) and full-wave bridges (octangular modules upper center). Texas Instruments' regular product line of high-voltage stacks is shown in the rectangular packages.



SPECIAL SEMICONDUCTOR ASSEMBLIES are being made on custom and standard product line basis by an increasing number of semiconductor manufacturers. Special component and circuit assemblies shown here with other special products were made by Hughes Semiconductor Division; all are encapsulated in plastics. Items are extended lead diode (1), diodes with special formed leads (2), potted diode with rugged leads (3), potted diode with ferrules for clip-in (4), single-ended Zener diode (5) and (6), matched diode pairs (7), matched diode quads (8), three Zener diodes (9), bridge (10), four parallel diodes (11), matched quad case (12), bridge (13), logic gate (14), three-input or gate (15), 2-kilovolt rectifier assembly (16), matched transistors (17), plug-in assembly (18), transistor NOR gate (19), cartridge rectifier (20) and (21), 7-kilovolt rectifier assembly (22), plug rectifier (23), bridge cast (24), ring washer bridge (25), and micro components (26 through 29).

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TYPE	PASS BAND (KMC)	PEAK POWER (MW)	WAVEGUIDE SIZE	DELIVERY (IN DAYS)
MPF-400	0.4-0.45 (UHF)	5	WR-2100	90
MPF-800	0.75-0.98 (UHF)	0.1*	WR-975	90
MPF-1001	1.2-1.4 (L)	10	WR-650	90
MPF-2501	2.6-3.1 (S)	5	WR-284	60
MPF-2502	2.6-3.6 (S)	5	WR-284	60
MPF-4000	5.0-6.0 (C)	1	WR-187	60

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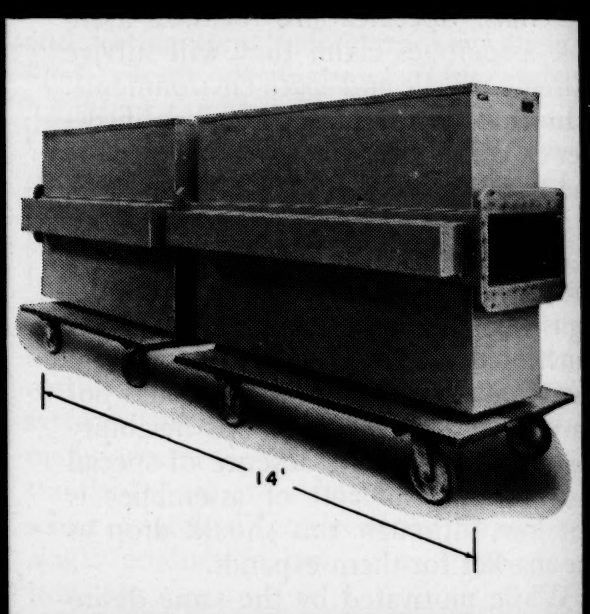
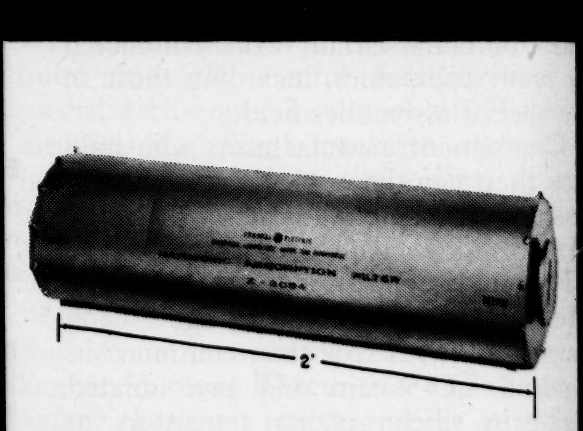


MPF-400 (UHF)



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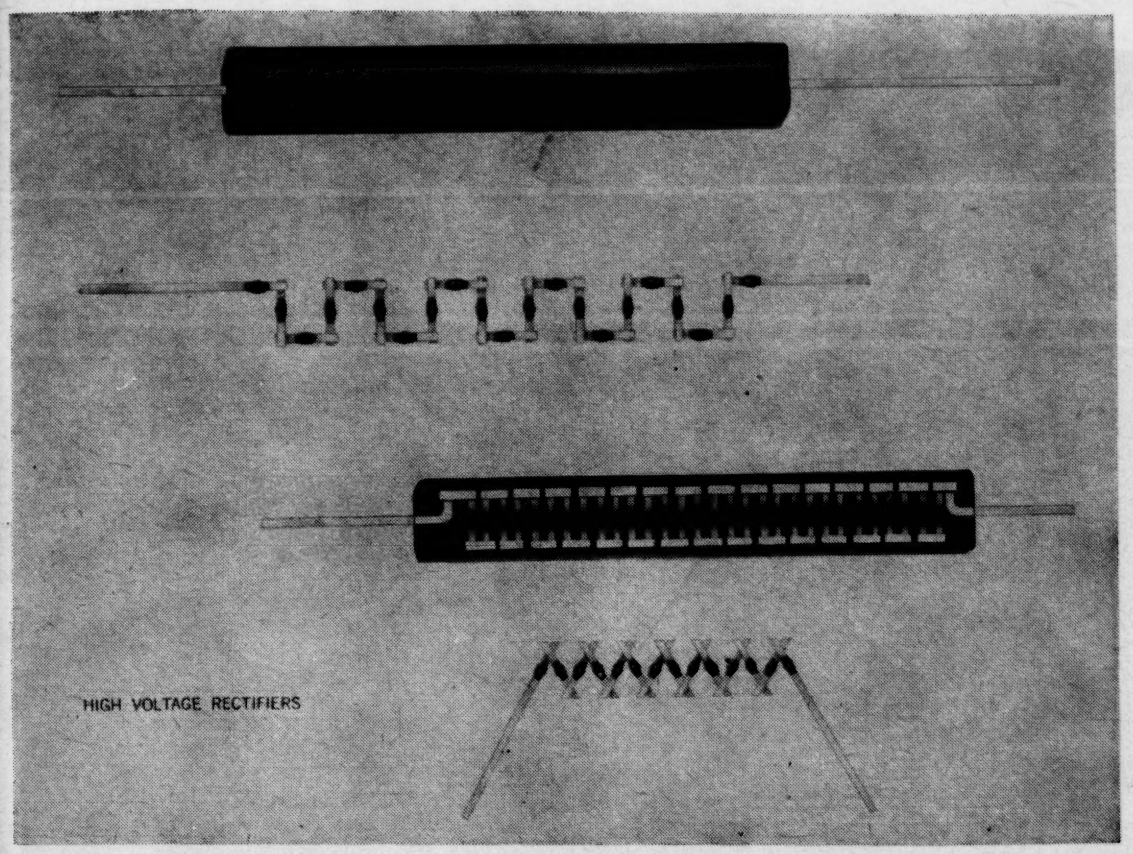


CONSTRUCTION of a typical special component assembly requires welding leads of several individual components and then encapsulating the entire assembly as is illustrated for this Pacific Semiconductors high-voltage micro cartridge rectifier. Individual diodes shown welded in two strings are company's micro diodes.

rectifiers are a standard line, however), but plans eight or 10 special circuits to be sold much as components are today. Ultimately, Hughes expects special assemblies to account for almost 40% of the division's volume. Recently the company organized a packaged assembly service department which offers customers a choice of components from any manufacturer for its assemblies. Assemblies fabricated by Hughes contain sealed components and are encapsulated in one of several plastics ranging from one with maximum dielectric strength to another with maximum mechanical strength. Generally, if the customer does not specify a package size for a standard component assembly, he may get one of several preferred package sizes. For a bridge this might be 200 x 500 x 625 mils, for a matched diode quad 175 x 500 x 450 mils. Stick rectifiers are fabricated by bonding rectifier cells in series, inserting them into a tube and then encapsulating the assembly. One stick rectifier, a 10-kilovolt unit, contains 16 series rectifiers. Assemblies are made with tube bases, solder terminals, clip-in pins or wire for printed circuit insertion.

• **International Rectifier,** El Segundo, Calif.—This firm markets a variety of special assemblies including rugged silicon Zener voltage reference elements, containing three-series connected Zener diodes in a welded metal can and a miniature voltage reference pack in a cylindrical epoxy package for insertion into a printed circuit board. In addition, super-power high-voltage columns capable of delivering up to 1,000 watts per cubic inch are available. The voltage reference element, 1N430, contains diodes in reverse and forward polarity with positive and negative temperature coefficients for optimum temperature stability. The entire body is a heat sink. The reference pack houses three Zener diodes and a transformer and provides a stable output voltage.

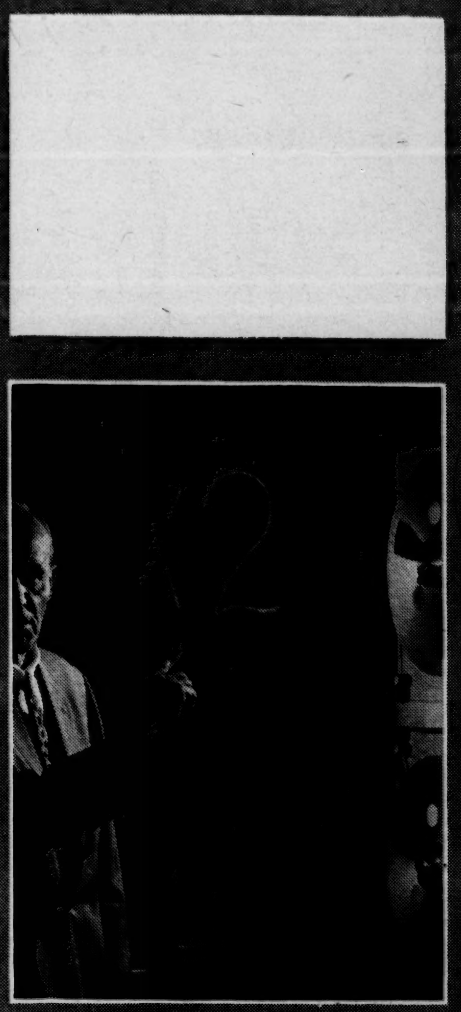
• **Pacific Semiconductors,** Culver City, Calif.—Company markets what is regarded as one of the broadest available lines of special assemblies in a wide range of package configurations, sizes, and lead arrangements. Standard lines of "off-the-shelf" units include high-voltage cartridge rectifiers, bridge rectifiers, low-temperature coefficient voltage reference diodes, low-voltage precision regulator diodes and micro-assemblies.

Specific assemblies available include the following:

► **High-voltage rectifiers**—Fuse clip types covering piv range from 1,500 through 20,000 volts, passing currents up to 500 milliamps. An axial lead series can withstand 500g shock and 100 cps. vibration with peal acceleration of 10g.

► **Bridge rectifiers**—In special encapsulations designed for chassis, terminal board and printed circuit mountings, these bridges use four 1N645-649 rectifiers. Standard lines cover the 225 to 1,000 volts piv range (1.5 to 325 milliamps) and are packaged in an aluminum heat sink with a base plate for simplified mounting.

► **Modulators**—Low-frequency bridge and ring modulators make balancing potentiometer and bleeder resistors unnecessary because of the high conduct-



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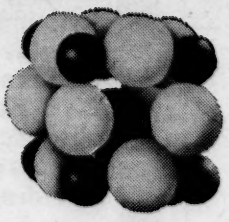
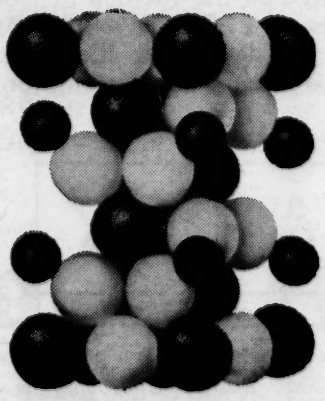
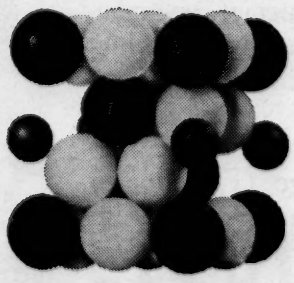


Perovskite



Five layers



Three layers

A number of new oxide compounds with the perovskite structure have been developed by one of our research groups. Investigations of related three-layered and five-layered structures are also in progress. To discover the relationships between crystal structure and physical properties, intensive studies are being carried on to determine ferroelectric, ferromagnetic and dielectric characteristics. From this basic research may come advanced materials superior to any currently available. • Our corporate-sponsored research programs into the fundamental nature of matter offer *unusual opportunity* to any scientist interested in doing *original work*. Inquiries are invited particularly from those with experience in—Solid State Physics • Plasma Physics • Particle Physics • Nuclear Engineering • Gaseous Electronics • Direct Conversion • Surface Chemistry.

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Tandem Transistor

(FORERUNNER OF SPECIAL SEMICONDUCTOR ASSEMBLIES)

Special semiconductor assemblies, or groupings of two or more separate, identifiable avionic components housed in a single enclosure, currently are being offered in greater varieties by an increasing number of manufacturers. So promising is the prospective market for these devices that several companies have elevated special assembly departments to full product line levels equal in stature with their transistor or diode lines. Special assemblies, however, are not really new to the semiconductor business. Two or three manufacturers, including Hughes Semiconductor, Transitron Electronic and Pacific Semiconductors, have been marketing them for some time.

One of the earliest special semiconductor assemblies was the "tandem transistor"—two transistors in a single shell, described at the 1955 Western Electronic Show and Convention and reported in Aviation Week shortly thereafter (AW Sept. 19, 1955, p. 95). Experimental models of the device with the emitter of the first internally connected to the base of the second were developed by Hydro-Aire, one of the pioneers in the semiconductor business. This work was done in connection with studies of free power communications gear, that is, transistorized gear whose power requirements would be so low that they might be satisfied by RF power radiated from broadcast stations. The advantage, cited at the time for the tandem transistor, was the increased frequency stability made possible by eliminating the external connections otherwise necessary to two normal single-stage devices. Hydro-Aire subsequently sold the group responsible for this semiconductor work to National Aircraft which later withdrew from the transistor field.

ance, low reverse current and accurate match of the diodes.

▸**Micro-assemblies**—Assemblies using the company's micro diodes and micro transistors can be obtained in off-the-shelf functions such as bridge rectifiers and high voltage rectifiers or can be made up in other configurations such as NOR circuits or binary counters by customer request.

▸**Silicon regulator and reference diodes**—Low-temperature coefficient voltage reference diodes use selected forward and reverse biased diodes connected in series to achieve a temperature coefficient of less than 0.005% per deg.C. Higher voltage reference elements are obtained by series adding these blocks as used in reference diodes.

▸**Low-voltage precision silicon regulator diodes**—Two series of regulators lower limits of normal Zener diodes to 1.5 volts and provide low dynamic impedance characteristics, according to Pacific Semiconductors.

This company will package matched pairs, quads, ring modulators, rectifiers, etc., in four basic encapsulated packages capable of meeting rigid military environmental tests. The encapsulant has dielectric strength of 400 volts/mil and resistivity exceeding 10^{14} ohm-centimeters. The packages are rectangular with leads out the top or bottom or both, tubular with axial leads, square with leads on top or bottom or rectangular with fixed dimensions. All leads are situated on a 100-mil grid system. Length of the rectangular and tubular packages is fixed by the number of diodes and rectifiers in them.

• **Radio Corp. of America,** Somerville, N. J.—Rectifier stacks and the first of a line of recently announced multiple junction devices—a Siamese twin-planar transistor for use as a d.c. chopper, differential amplifier, etc. The two transistors (common collector) undergo similar stresses, are subjected to same temperatures and environments and other conditions so that their final electrical and thermal properties are closely akin making the unit suitable for differential amplifier applications.

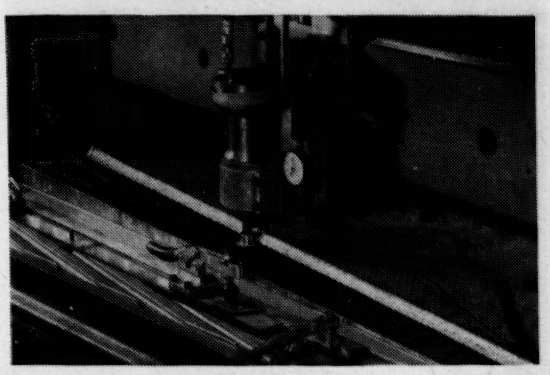
• **Rheem Semiconductor Corp.,** Mountain View, Calif.—Firm has regular product line of special subminiature and microminiature component assemblies, such as stick rectifiers, matched diode pairs and quads. Typical matched quad package is, according to Rheem, rectangular in shape (200 mils high, 500 wide and 468 long) with axial leads.

• **Texas Instruments,** Dallas, Tex.—Texas Instruments is marketing Types 1N2878 through 1N2925, a line of series-connected silicon diode high-voltage stacks as a regular product line. Each component is cushioned in silicone rubber or other resilient material and encased in a rectangular epoxy package. These are housed in four different assembly sizes in each of two package types, one with axial the other lateral leads. Peak inverse voltage ratings for up to 13 diodes in series range to 6,500 volts. Stacks are "ruggedized" to meet military requirements. Average rectified current is 250 mils. Bulk of Texas Instruments' semiconductor assemblies effort is centered on custom circuit design using all semiconductor components—transistors, resistors, capacitors and diodes. Complex computer and logic circuitry are available to customer specifications.

• **Transitron Electronic Corp.,** Wake-

DESIGNING WITH HEXCEL

Aluminum Honeycomb: Forming and Contouring



Contouring Aluminum Honeycomb with Apex Router

Forming and contouring of aluminum honeycomb can be achieved simply, successfully and economically. Honeycomb contouring operations once thought extremely difficult have now become commonplace.

Curved panels are manufactured by roll-forming expanded honeycomb and bonding the separate pieces together. With normal sheet-metal rolls, cylindrical and spherical radii as small as 5 to 10 T are produced in aluminum honeycomb, while special techniques have been developed to form parts with radii as small as twice the thickness of the honeycomb core itself. By filling and milling, routing of unsupported core, and chem-milling, three-dimensional carving of honeycomb core materials makes possible the assembly of complex contoured structures.

High-speed routers account for most production contouring of honeycomb materials; a small jeweler's saw cupped on a vertical spindle is the usual cutting device. Aluminum and reinforced plastic honeycomb are simple to carve with router-type equipment, and the applications of honeycomb produced in this manner are many: contoured cores for rotor blades, control surfaces, conforming doors, duct assemblies.

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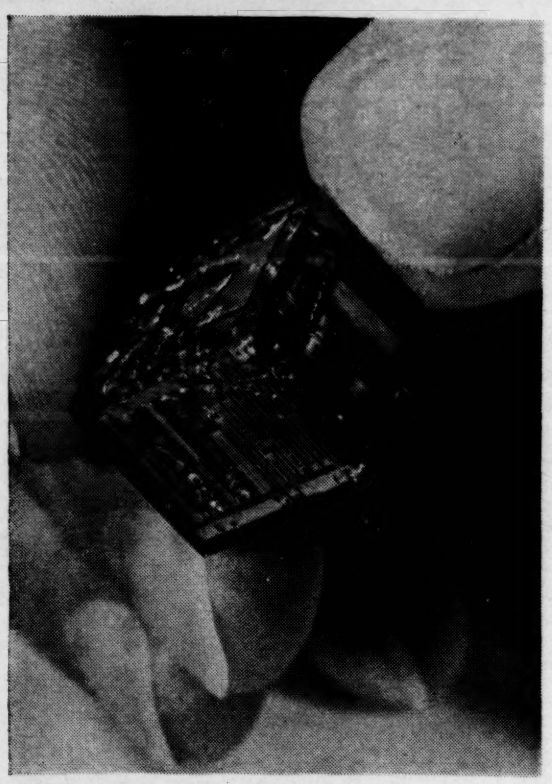


Welded Module

Welded amplifier module to be used in the infrared guidance system of the Redeye missile achieves sizable savings in weight and space compared with printed circuit board techniques, while still employing conventional subminiature avionic components (AW Aug. 24, 1959, p. 104). Components are tightly packed and encased in plastic after leads are welded, rather than soldered. This packaging method is expected to be used in fabricating analog avionic subsystems for Tartar and Mauler as well as Redeye missiles at Convair/Pomona.

field, Mass.—Company's Packaged Assembly Department specializes in the design and production of a variety of custom-made, high-quality epoxy resin encapsulated or hermetically sealed semiconductor assemblies. Among these are diode quads and high voltage assemblies, a line of series-connected rectifier cells within non-conductive high-temperature resin cases. Rectifiers are available in tubular enclosures with axial leads in piv ratings to 10,000 v.

Length of the enclosure (½ to 2 in.) is a direct function of the number of cells in series. Another line of rectifiers is contained in rectangular enclosures.

Transitron's encapsulated plug-in silicon and germanium diode quads and silicon rectifier quads are housed in standard seven-pin JETEC E7-1 miniature base (¾ in. diameter pill box). The silicon diode quads have matched forward characteristics and low inverse leakage current. Basing diagrams for these units show two pairs in series with a center tap terminal on each pair, four terminals for each end of two series, plus internal connection from cathode to the seventh terminal. These units can be wired as a bridge, ring, voltage doubler, center-tapped rectifier or simply half-wave series strings. Applications could include rectifier circuits, ring modulators, phase comparators and blocking diodes up to 50 kc.

Microminiature component assemblies designed to meet specific customer specifications also can be obtained from the firm.

Besides these organizations, a number of other companies, Sylvania Electric Products, Woburn, Mass., Sperry Semiconductor Division, So. Norwalk, Conn., and the newly formed Micro Semiconductor Corp., Culver City, Calif., report plans to market assemblies in the future. Micro Semiconductor says its initial assemblies, primarily pairs, matched quads and stick rectifiers, will use surface passivated silicon micro diodes (25 mils square x 10 mils thick) potted in epoxy resins and qualified to meet military specifications.

Partly an outgrowth of semiconductor component assemblies are assemblies containing complete circuit functions made by interconnecting individual components within a single package. Like component assemblies, these often are made up on a custom basis and eventually move into a normal product line. A few companies which make circuit assemblies do not make component assemblies, however.

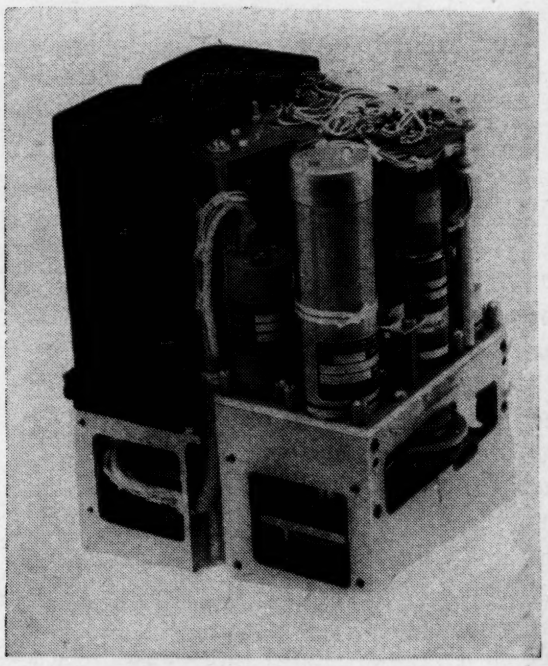
The circuit assembly is viewed by some companies as an interim step, of perhaps several years or more duration, preceding the acceptance by the industry of integrated circuits—where a basic function is performed within a single solid.

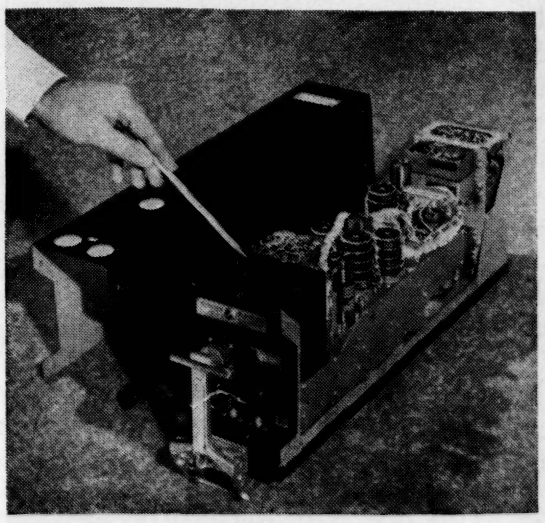
Custom special assembly work will progress simultaneously with integrated circuits development, this view maintains. Fairchild Semiconductor, one company which holds this viewpoint, believes special assemblies will be part of the semiconductor business for a long time even with the advent of practical integrated circuits such as its own Micrologic circuits (AW Apr. 11, p. 94). Many special orders will be cheaper, more efficiently produced as special assemblies rather than as integrated circuits, this company says.

Fairchild's Special Products Group, which turns over its special product orders in about two weeks' time, has about 30 products, ranging from five-nanosecond diodes or three-planar transistors in a TO-5 assembly to special matched pairs in TO-5 or the smaller TO-18 case. Some of its special component and special circuit assemblies include medium- and high-power Darlington configurations, a transistor and four diodes connected as a digital computer logic element, a diode bridge in a TO-5 assembly and two diodes with forward voltage drops matched to two millivolts fitted within a TO-5 assembly.

Making special assemblies requires many of the diverse skills acquired by the semiconductor industry over the past 12 years plus a good bit of foresight.

One relative newcomer to the semiconductor business, Rheem Semiconductor, describes the facility where it conducts assemblies work as a combination small quantity job shop and chemical laboratory rolled into one. When it drew up its construction plans for its present production facility, Rheem says, it set aside separate rooms for special assembly work. In addition to this space, the company retained a large area in one of its earlier production buildings as a production backup for large quantity orders of cus-





Versatile Transducers

Modules of AiResearch Division of the Garrett Corp. are individually removable for replacement and do not require recalibration when replaced. Mach altitude transducer module is shown (top). Note precision gears. Central air data computer (bottom) developed by AiResearch occupies about 190 cu. in. and weighs 20.5 lb. (Version for the F-104G weighs 24 lb.) Pointed out in the photo are the two force balance transducers which accept pressure information and convert it to a mechanical signal. Circuitry of computer reduces indicated readings to true readings for autopilot, navigation and bombing systems.

tom special assemblies. This gives the firm a latitude in handling large, intermittent assembly runs.

Among the organizations now marketing or about to introduce semiconductor circuit assemblies are:

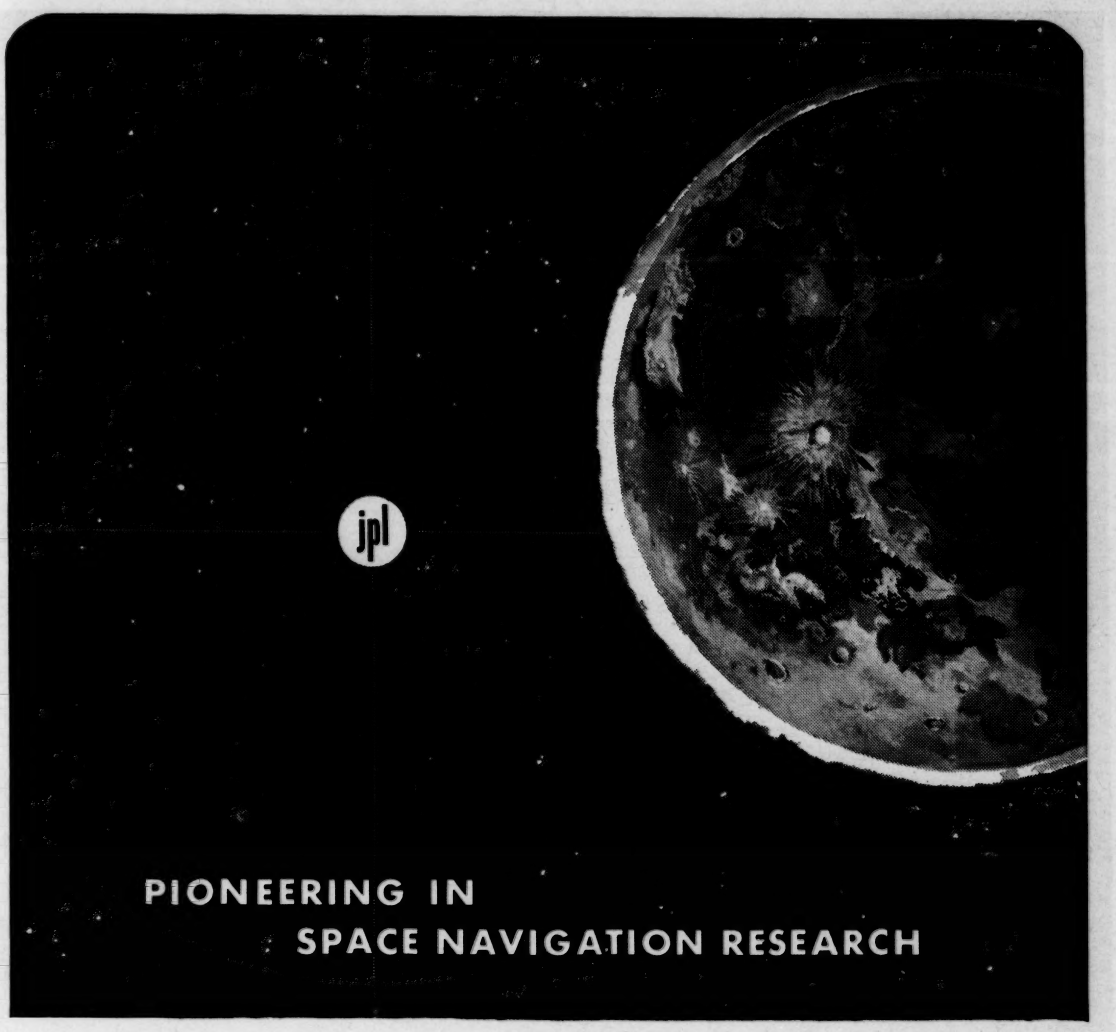
• **Delco Radio Division,** General Motors, Kokomo, Ind.—Potted germanium and silicon transistor digital circuit modules are available. A line of 10-mc. potted modules and another of ferrite aperture plate buffer memories may be introduced shortly. This line of welded modules includes circuits such as logic inverters, three input diode gates, four input diode gates, power inverters, flip-flops and free-running multivibrators. Each block contains components with resistance-welded lead interconnections. Assemblies are vacuum-encapsulated in a filled epoxy resin. Each module measures 800 mils in height, one inch in length while the width ranges from 200 mils in direct multiples of the minimum width to one inch depending on the circuit. Pins, laid out on a 100-mil grid system, can be dip-soldered to printed circuit boards or resistance welded for interconnection.

• **General Electric** (Syracuse, N. Y.)—Heavy Military Electronics Department offers its series M transistor logic elements—transistor nor gate, emitter follower and binary element. Switching speeds up to a megacycle can be obtained with these logic elements, all encapsulated and to be used as building blocks in digital computer and data handling systems. The elements can be obtained with a variety of terminations. In addition, General Electric has a short cycle, custom design service for supplying core-diode shift registers. A typical shift register design provides maximum shift rate of 100 kc., recommended shift rate up to 95 kc. over a typical military environment. The register might be packaged in a ½-inch cube. Company's custom packaging operation supplies high-density miniature components in various configurations, colors and terminations on a four- to six-week delivery schedule. Typical packages might include inverters, flip-flops, encoders and amplifiers.

• **Pacific Semiconductors**—Company is now offering digital computer modules and computer logic modules containing micro components.

• **Raytheon** (Newton, Mass.)—Nine standard logic circuits potted in epoxy resin and made by welded-module technique are being offered by Raytheon in such circuits as nor gates, flip-flops, emitter followers, diode and and-or circuits, and inverters

Digital and communications circuits packaged in its micromodules can be obtained on a standard line or custom basis from Radio Corp. of America.



The Jet Propulsion Laboratory in Pasadena, California, has been given the responsibility by the National Aeronautics and Space Administration of managing and executing a number of highly significant explorations in space. They include lunar and planetary missions such as fly-bys, orbiters, and unmanned roving vehicles for the observation of the surface of the moon and the planets. Other missions planned for the future involve trips outside of the ecliptic and beyond the confines of the solar system.

The successful execution of these programs requires extensive research efforts of a basic nature in the areas of celestial navigation and the guidance and control of vehicles operating far out in space. The problem areas being investigated include novel concepts in navigation based on astrophysical phenomena as well as research on inertial, optical, and electro-optical sensors of various types.

Other examples of present research activities in this area are cryogenic studies related to gyro and computer techniques, gas lubrication and flotation of sensing masses, research in solid-state physics, and many others.

The Laboratory has a number of positions open for scientists who are interested in working on challenging problems in these areas and who have the ability to investigate novel concepts and try unconventional methods.

Applicants must have an outstanding academic background with a Ph.D. degree, or equivalent experience and a Masters degree, in physics, astronomy, or electrical engineering. A minimum of five years of industrial or academic experience in the following fields will normally be required: **optical physics, astrophysics, cryogenics, inertial guidance, celestial navigation,** and **computer and logic devices.**

Qualified scientists will be offered the opportunity to work in an unusually stimulating atmosphere and will have available excellent supporting facilities for experimental and analytical studies.

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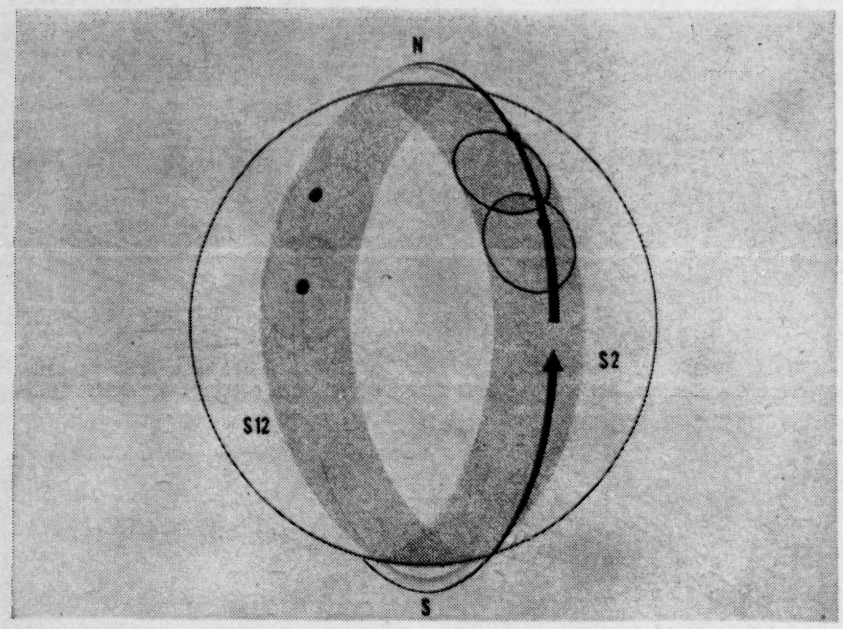
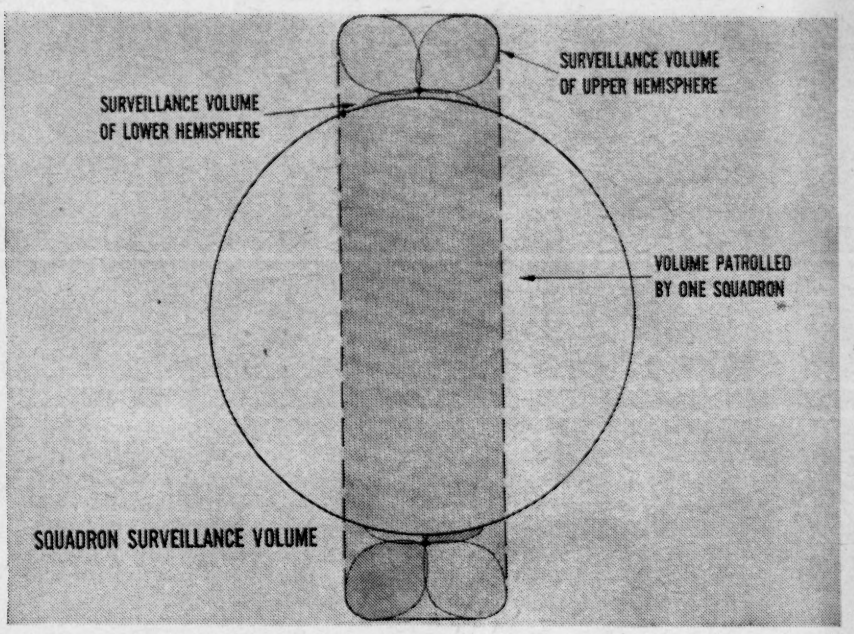




ANTI-ICBM surveillance concept suggested by Ryan Electronics engineer would consist of 12 squadrons of earth-orbiting patrol satellites with 12 satellites in each orbit. Surveillance areas of adjacent satellites as shown for squadrons 12 and 2 would overlap (left). Total surveillance volume covered by two squadrons counter-orbiting in same plane would be belt around the earth (right).

144-Satellite Anti-ICBM Concept Studied

Los Angeles—Avionic requirements of an orbiting earth satellite fleet capable of detecting, tracking and assisting in the destruction of hostile ICBMs were outlined here recently in a report before the Institute of Radio Engineers' Winter Military Electronics Convention.

The report, based on a company-funded study, was presented by Martin N. Kaplan, a senior research engineer at Ryan Electronics.

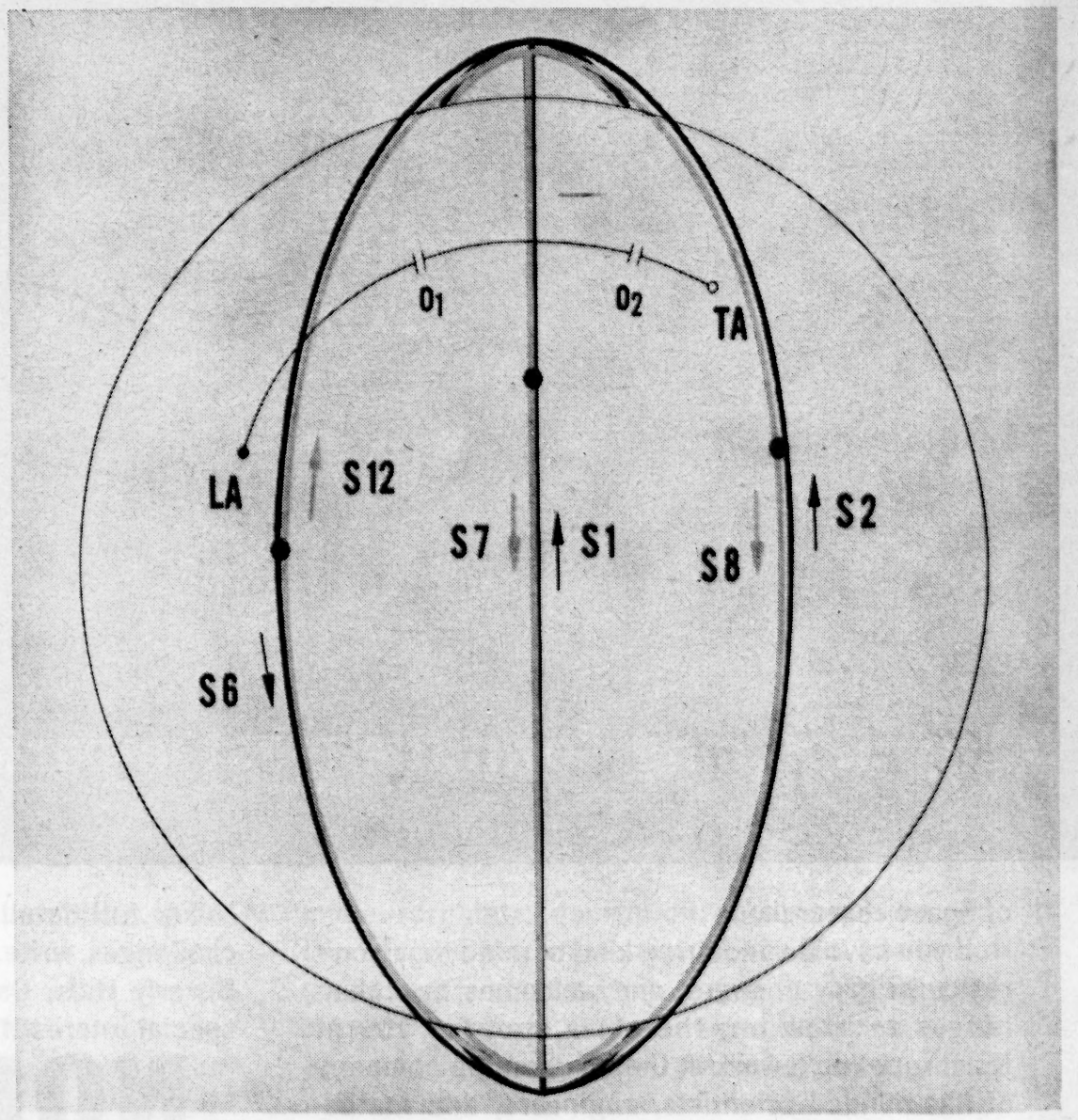
For a number of technological reasons, Kaplan's concept of the anti-ICBM fleet, which is capable of keeping the earth's entire surface under constant surveillance, is and probably will remain for at least several years beyond current technological capabilities. Adequate communications for such an ideal defense, or similar and perhaps more easily realizable concepts of satellite warning systems, appear within reach of present avionic technology. The avionic needs of the ideal satellite fleet cited by Kaplan do illustrate what the requirements and potential capabilities of such spaceborne systems might be.

144 Satellites

Kaplan estimates that 12 squadrons of earth-orbiting satellites, each containing 12 satellites or patrol craft operating at practical altitudes, could keep the entire surface area of the earth under constant scrutiny. Half that number of satellites—72 vehicles—could do the job but not with the reliability expected from the full 144.

In Kaplan's 144-satellite plan, the squadrons would be injected into circular, polar orbits, ranging in altitudes from approximately 100 to 220 stat. mi. Each squadron's orbital plane would pass through the earth's rotational axis; individual squadrons would be stacked at intervals of about 5 mi. to avoid collisions over the earth's poles. The mean distance between craft traveling in tandem in each orbit would range from roughly 2,130 to 2,200 mi.

Pairs of squadrons would rotate the earth in coplanar orbits. The two squadrons in each plane would rotate in opposite directions to assure radar, infrared and optical coverage of fringe areas between and about any satellite and to overcome the problem created when infrared sensors of any satellite



BALLISTIC MISSILE launched from launching area (LA) would be detected and tracked by patrol satellites in squadrons 6 and 12; acquired by next pair of squadrons at point 0_1 and tracked by them until picked up at point 0_2 by squadrons 2 and 8.

facing the sun are swamped by sunlight.

Any satellite in this fleet, Kaplan estimates, could view instantaneously a circular area of about 2,000 mi. in diameter. Thus, each pair of squadrons would effectively cover a 2,000-mi. belt (north and south) about the earth.

About each satellite would be a number of gimballed antennas for radar tracking of targets. Four telemetering antennas for microwave communications with adjacent vehicles and one for communications with ground tracking stations would be part of the satellite's avionic complement. Other equipment which Kaplan suggests be included:

- **PPI pulse-echo,** 1,000-mi.-range search radar. Its 35-deg. fan-shaped antenna pattern would be capable of detecting medium cross-sectional targets traveling below Mach 3 in the lower half of the vehicle's hemisphere. This might provide bearing, Doppler and range information.
- **PPI pulse-echo** search radar, range roughly 1,600 mi. Its 95-deg. fan-shaped antenna pattern might detect small radar cross-sectional targets at velocities above Mach 3 where the target is located in the vehicle's upper half hemisphere.
- **Eight automatic pulse-echo** tracking radars, range approximately 1,000 mi., whose pencil beam antenna patterns would track targets traveling above Mach 3 in the upper hemisphere.
- **Four automatic pulse-echo** tracking radars, range approximately 1,000 mi., for tracking ICBMs below Mach 3.
- **Carrier-wave Doppler radar** for roll axis orientation at altitudes from about 75 to 250 mi. A radar altimeter for use at the same altitudes.
- **Three sensors** for establishing yaw axis vertical; star trackers for correcting satellite position in the orbital plane and indexing vehicles beneath the star Polaris.
- **Variety of infrared,** optical and CW Doppler radar sensors.

Heavy Satellite Required

To carry this equipment, a heavy satellite—perhaps 2.5 to 5 tons—beyond the injection capabilities of available boosters would be needed, Kaplan says.

Use of a combination of sensors might ensure that at least one sensor would pick up the target if conditions were unfavorable for others. If the infrared sensor were saturated by background sunlight, for example, a Doppler radar could pick up return from ionized gases of an ICBM during launch. Or after its burnout, when a missile is traveling against a dark sky, should a zero relative velocity condition arise, the infrared sensor might sense infrared radiation emitted by the missile's hot rocket motors.

How the orbiting satellite fleet might

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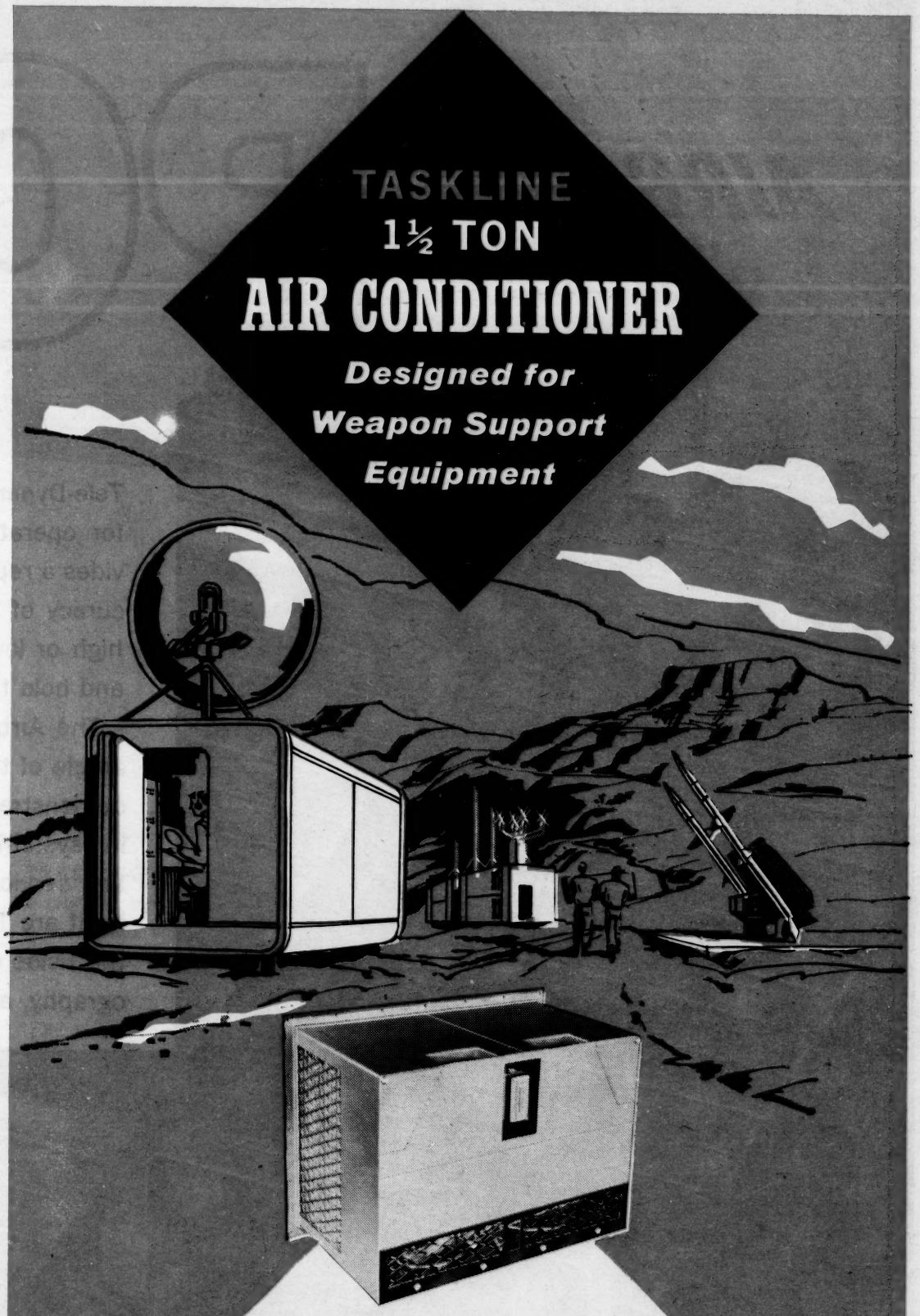

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TELE-DYNAMICS

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accomplish its detecting and tracking mission can be shown with drawings accompanying story. If a ballistic missile were fired from launching area (designated LA) and within the surveillance area of squadrons S6 and S12, bearing, slant angle and slant range data might be obtained along its trajectory by the sensors of satellites in these squadrons. As the missile continues on its course, vehicles of squadrons S1 and S7 would acquire the target at some point (designated 01) between their orbiting plane and that of squadrons S6 and S12, and continue to track it as it speeds toward target area (TA), until it is picked up by the next squadron or until the missile may be destroyed by anti-missile counterweapons.

Data Relay

Data about the hostile missile (HM) could be relayed via the satellite fleets to a ground central intelligence command (CIC) in two ways.

In the first, as shown by jagged lines, satellite 1 in squadron 12 might pick up and relay to satellite 2 of squadron 12 sequential tracking data. This data would then be relayed from vehicle to vehicle in the squadron, then be transmitted from squadron 12 vehicle to a nearby vehicle of another squadron over the earth's North Pole. Data would then be transmitted from vehicle to vehicle in squadron 8, finally be transmitted by microwave to a ground terminal and through coaxial cable to intelligence command. One-way travel time for such a message, according to Kaplan, would be approximately 50 milliseconds.

Alternate Relay

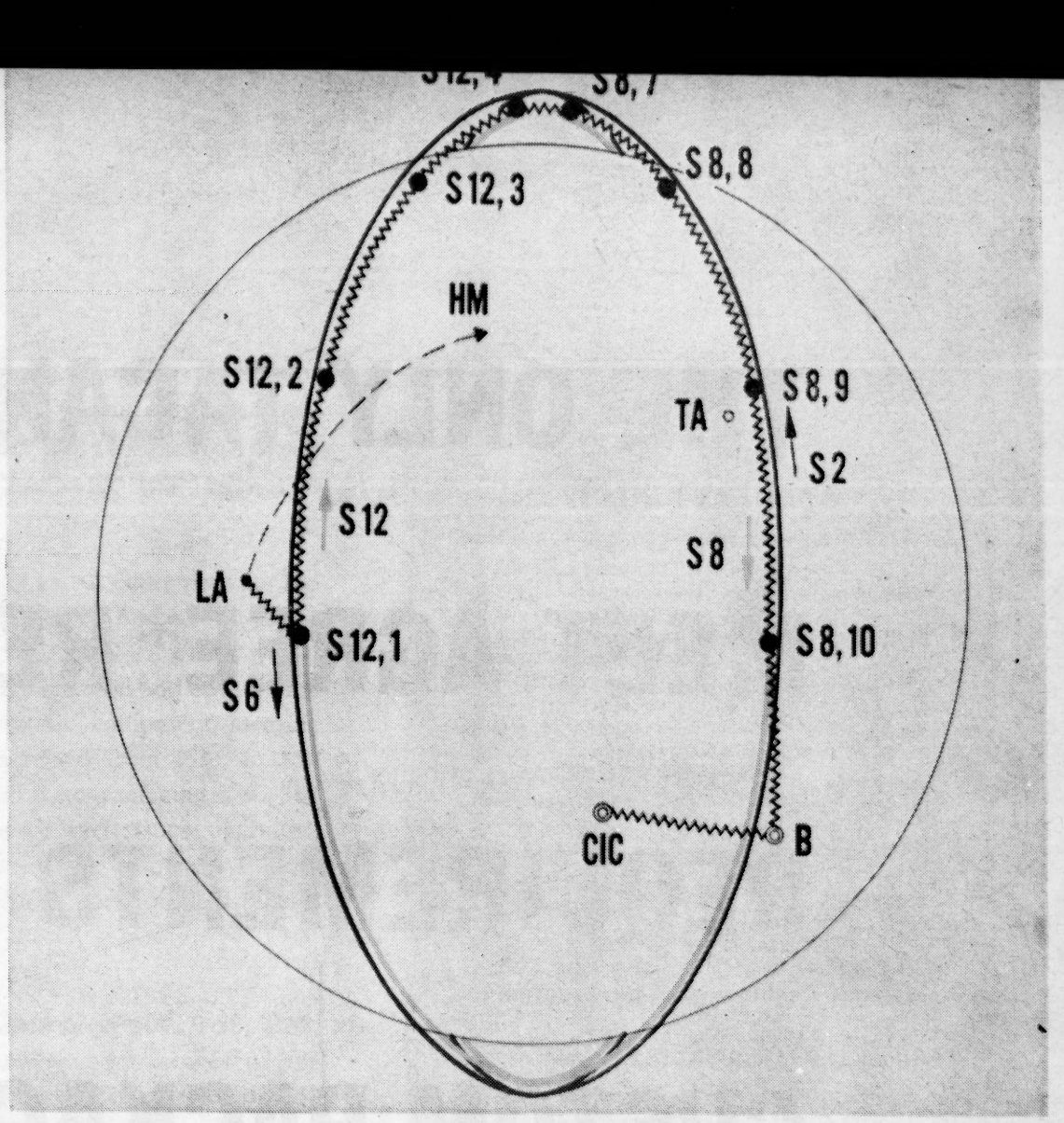
Alternately, the data might be relayed between vehicles which travel roughly abreast of one another but in different squadrons. Time for message transfer from the satellite which makes initial detection to its receipt at command might be roughly 25-30 milliseconds.

At intelligence command the ICBM's trajectory could be determined and the optimum counterweapon selected. The latter's mission of interception could then be monitored over the satellite communication network.

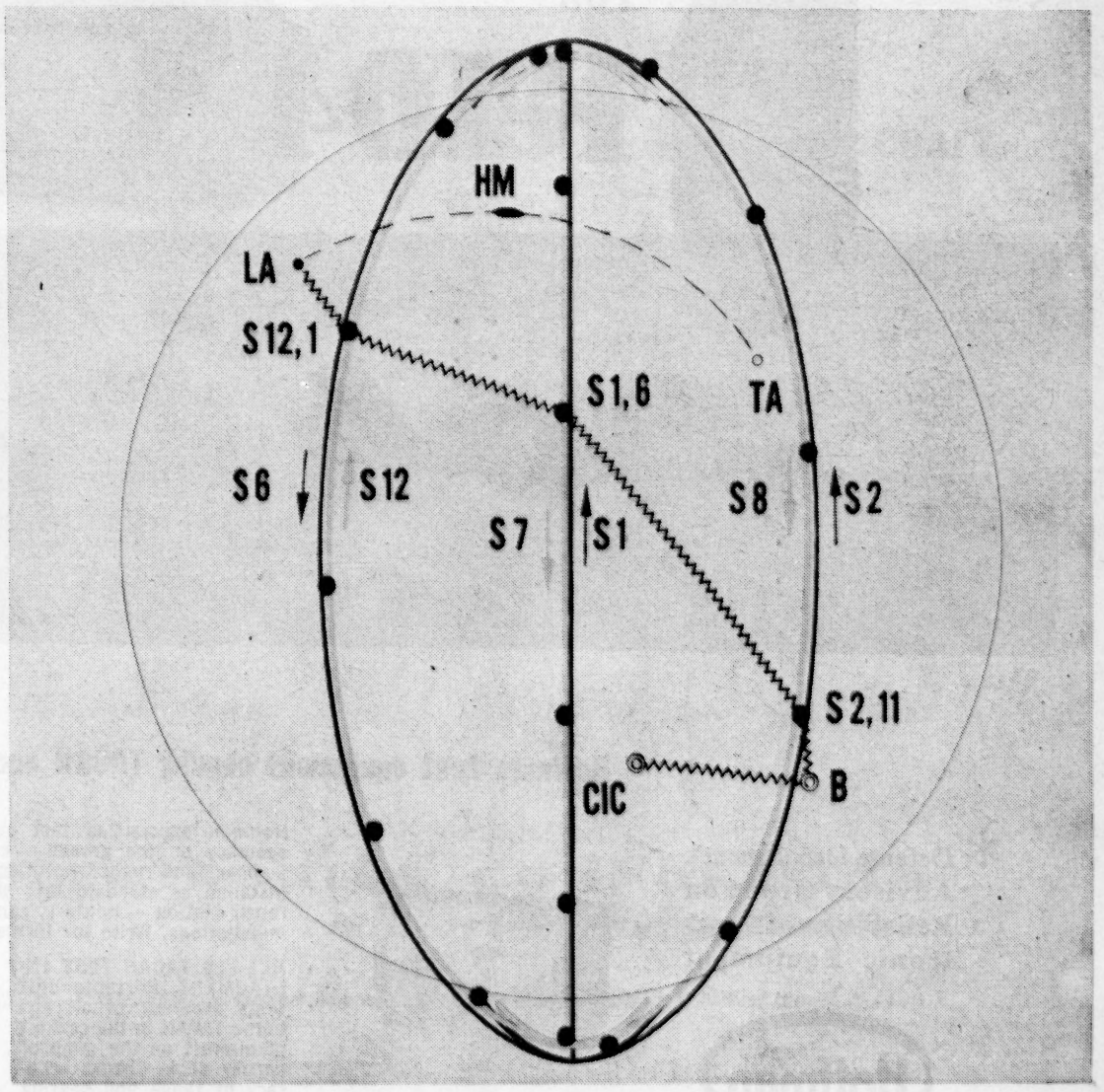
Guidance commands for the counterweapon could be supplied by the patrol satellites.

Satellite 6 of squadron 1 might track the hostile missile and the counterweapon (CW) from its launching point (D) to a rendezvous point, (E). Concurrently, trajectory data could be transmitted from satellite 6 of squadron 1 to satellite 11 of squadron 2, then to tracking station (B) and back to intelligence command.

Although satellite 6 exercises closed-



TRACKING DATA for hostile missile (HM) can be relayed from satellite to satellite within a satellite surveillance squadron and then to a satellite in another squadron at the earth's pole. Data would then be transmitted to tracking station B and sent by coaxial cable to central intelligence command (CIC).



ALTERNATE METHOD of transmitting data for calculating hostile missile trajectory and impact point would involve relay from satellites traveling abreast of one another in different squadrons. Here data is relayed from satellite 1, squadron 12, to satellite 6, squadron 1, then to satellite 11 in squadron 2 and finally to earth.

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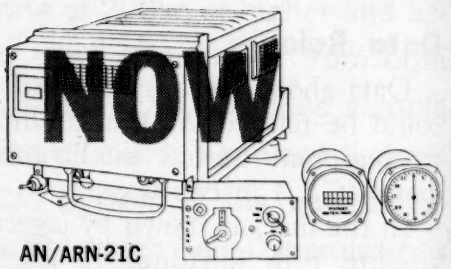

AN/ARN-21C

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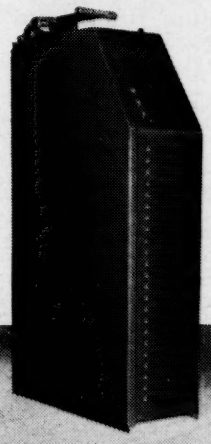
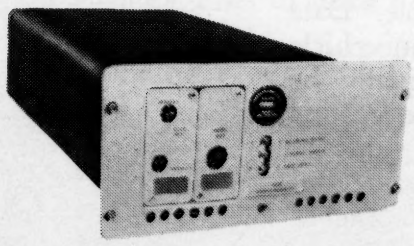


FOR

F-104



B-58

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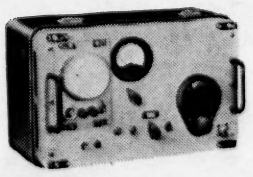

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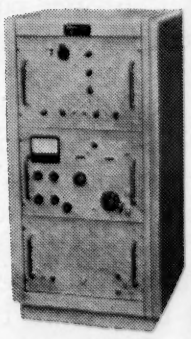

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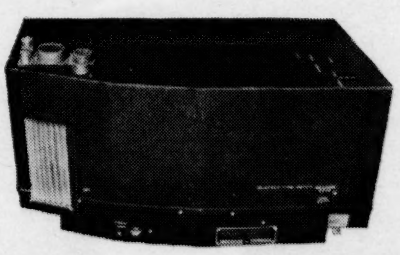
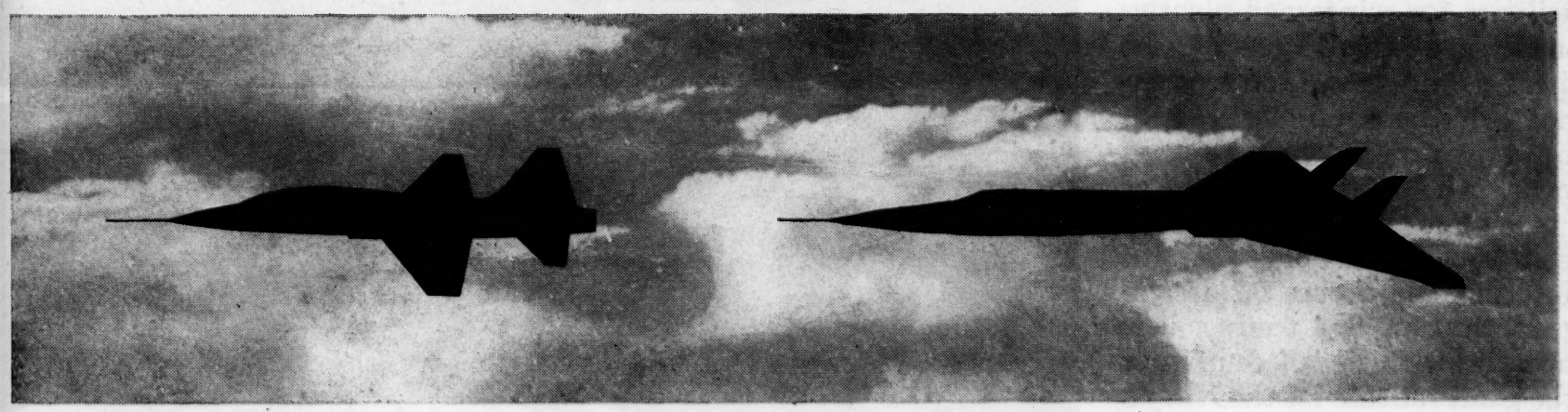
T-38  **XB-70 AIRCRAFT**



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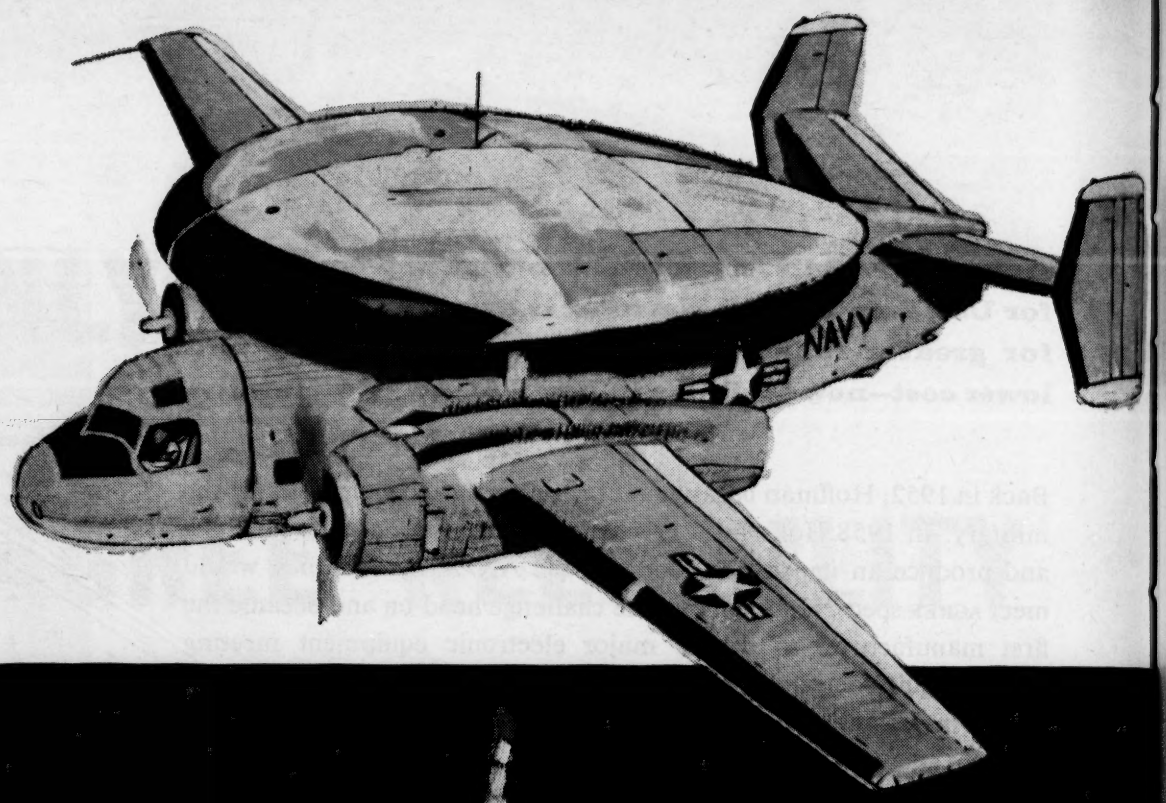

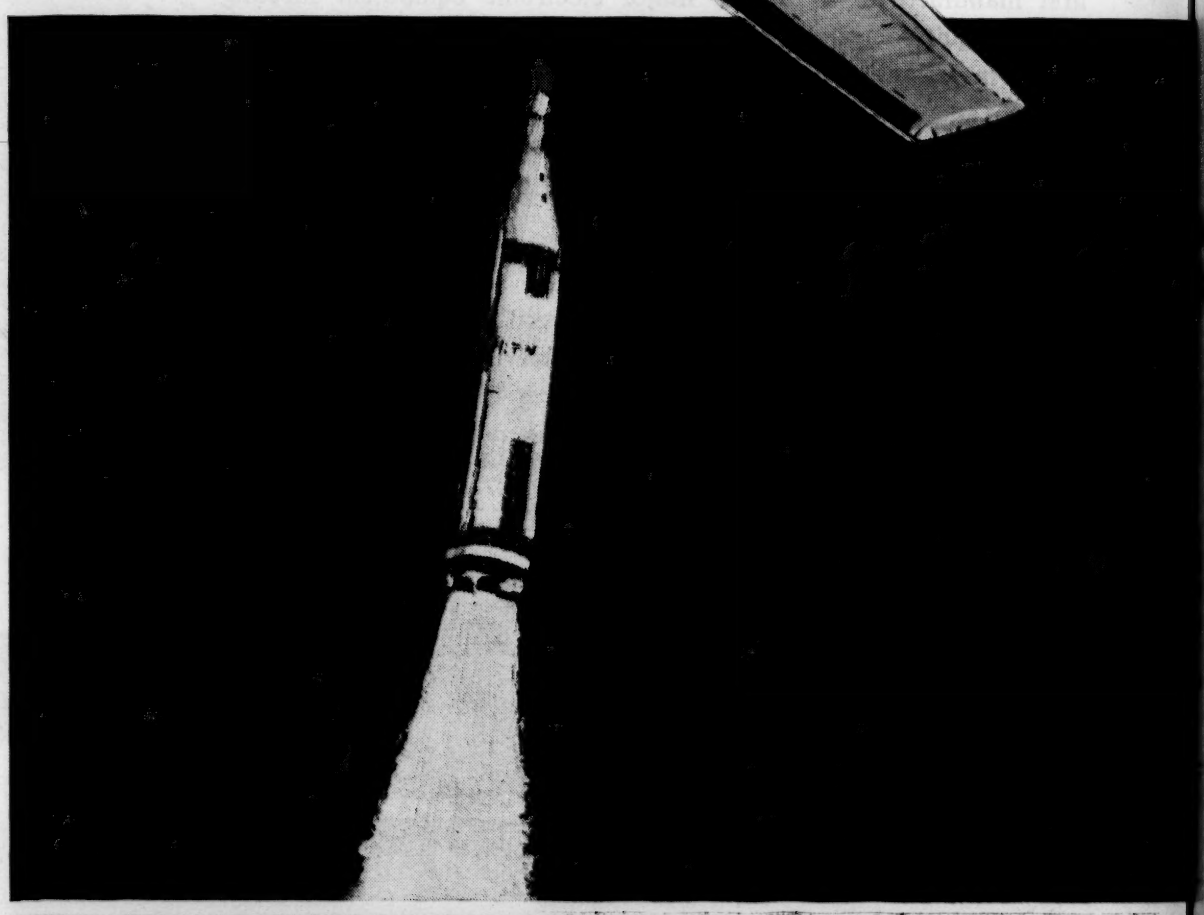

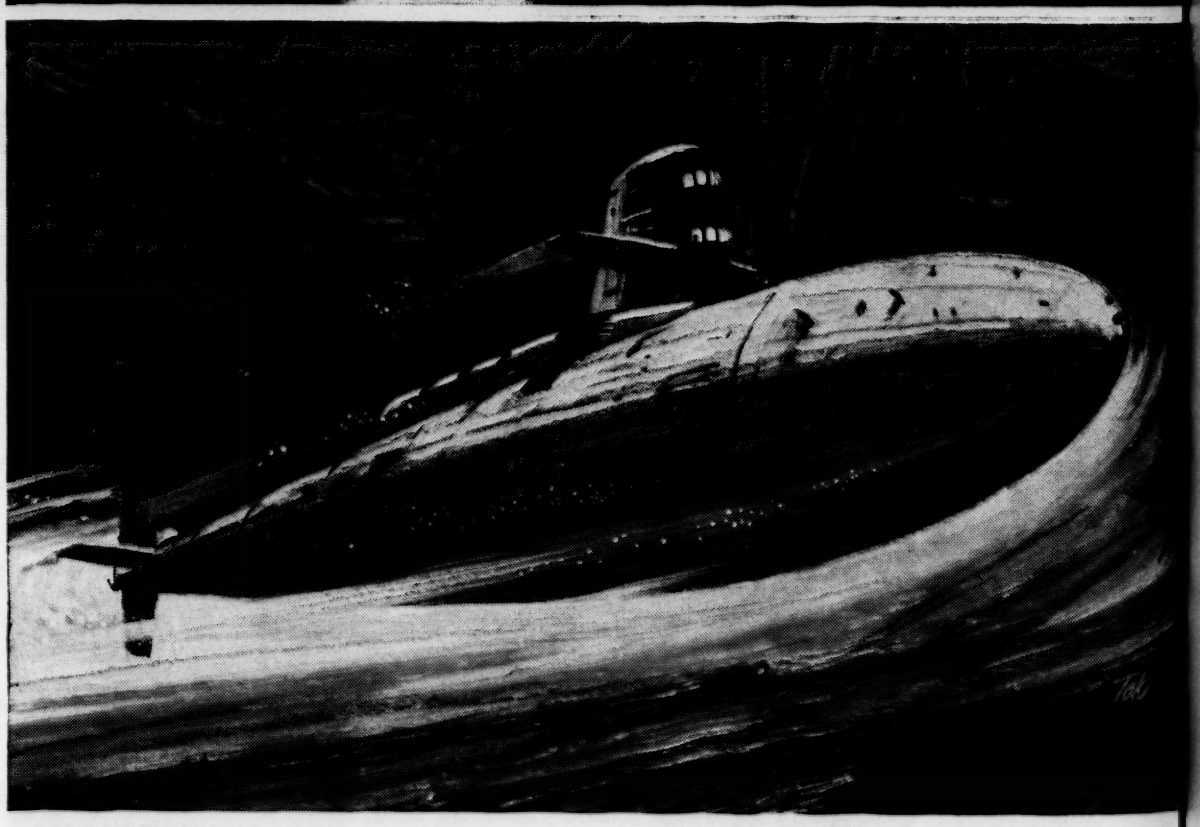

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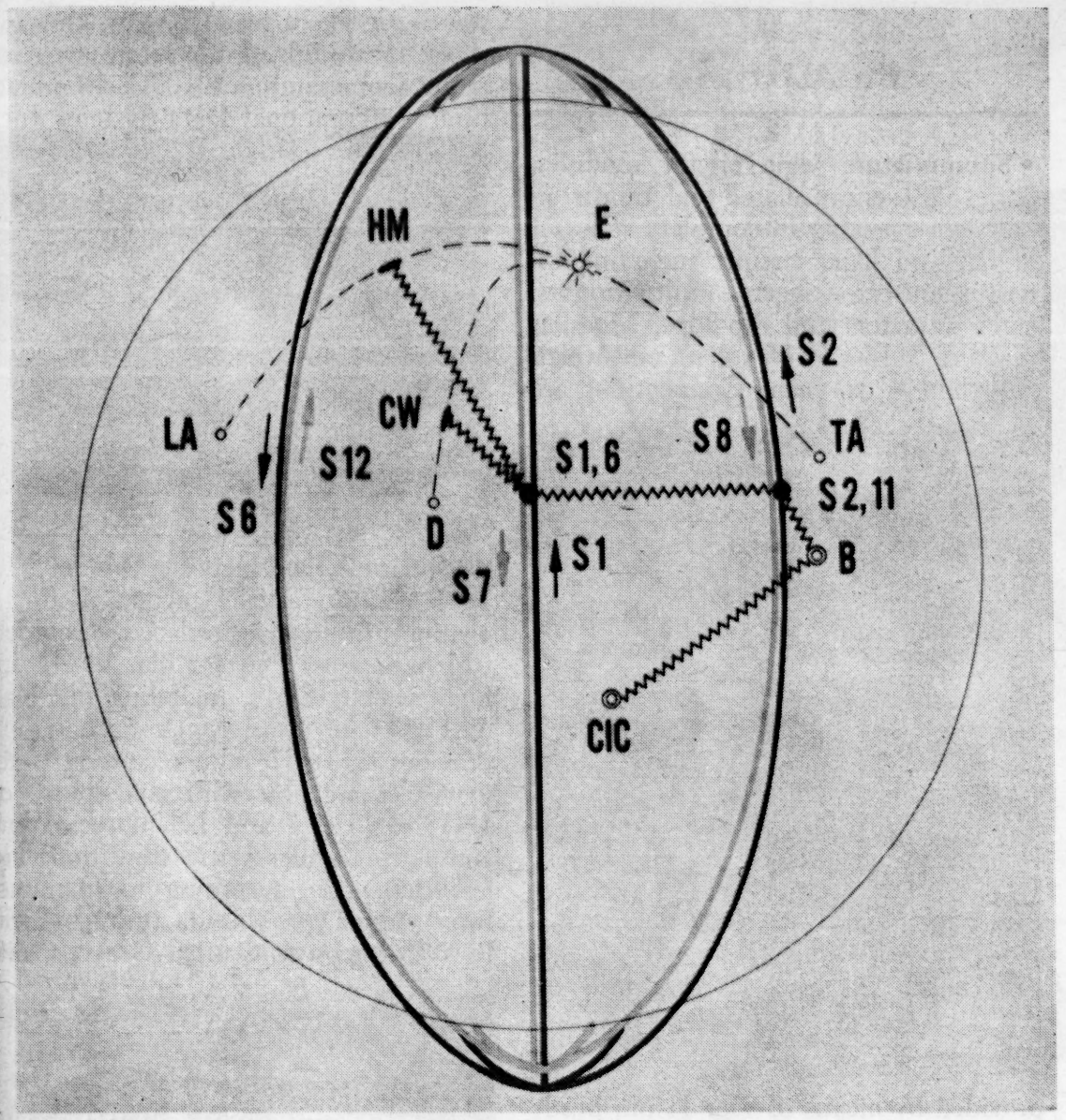

SATELLITE of surveillance fleet might supply radio guidance for missile counterweapon launched from D and brought to rendezvous with hostile missile at point E.

loop control of counterweapon, Kaplan observes, coarse counterweapon trajectory and rendezvous point could be found by computers located at intelligence command.

The counterweapon selected for a given mission should lie midway between the launching area and the target area along the projected route of the hostile missile.

For this purpose, deployment of counterweapons might require land sites, and/or sea-launch capability.

While the exact number of communication channels which would be required for the system is not known, it might run to 1,440 message channels. These might be necessary for detection and data transmission to ground, clear channels to counterweapon launching stations, surface-to-surface communications, action messages from intelligence center to remote counterweapon installations via satellite, and closed-loop control of counterweapon.

Byproducts of use of a surveillance satellite fleet, Kaplan points out, might include:

• **Navigation aid**—Navigation data might be supplied to surface, air or other space vehicles.

• **Rescue**—Surveillance fleet might assist in rescue of surface, air and space vehicles.

FILTER CENTER

▶ **Underwater Research Area Grows**—Santa Barbara, a small Pacific Ocean coastal community about 100 mi. above Los Angeles, is becoming the center of increased undersea warfare research largely because of its proximity to a deep water channel and a sea region with interesting oceanographic features. Raytheon has been conducting undersea work at Santa Barbara for some time. Now two other companies—General Motors and Emerson Electric—are setting up facilities in the same area. The Santa Barbara laboratories of General Motor's Defense Systems Division, located in what formerly was Curtiss-Wright's Dart missile plant at Goleta, is presently recruiting scientific and technical personnel for its sea operations department. The latter and an aerospace group are the two major divisions of the new GM facility.

▶ **RCA Opens Microwave Laboratory on West Coast**—A microwave engineering laboratory which will make L-band tunnel diode oscillators and amplifiers and L- and S-band parametric amplifiers has been opened by Radio Corp. of America at 6801 E. Washington Blvd., Los Angeles. The facility will be part of the Microwave Tube Operations of the RCA Electron Tube Division in Harrison, N. J.

▶ **Solid-State Circuits Digest Available**—A 116-page digest containing extended abstracts, circuit drawings and diagrams of papers presented at the 1961 International Solid-State Circuits Conference held recently in Philadelphia is available at $5 a copy from Henry G. Sparks, Moore School of Electrical Engineering, University of Pennsylvania, 200 So. 33rd St., Philadelphia, Pa.

▶ **Japanese Semiconductor Production Rises**—In the first nine months of 1960, dollar volume of Japanese semiconductor device production topped total semiconductor production for the entire previous year by over $2 million, the Electronics Division, Business and Defense Services Administration, U.S. Department of Commerce reports. Total Japanese electronics production, including military, industrial, commercial and consumer products, as well as components, was $856 million for the first three quarters of 1960 compared with $655.4 million for the same period of 1959 and $935.7 million for the entire year 1959.

▶ **Signed on the Dotted Line**—Major contracts recently announced by avionics manufacturers include:

• **Burroughs Corp.**, Detroit, $3.6-million contract from Rome Air Materiel Area for installation and logistic support of the AN/FST-2 coordinate data transmitting sets used in SAGE.

• **Hoffman Electronics Corp.**, Los Angeles, contract for approximately $3 million for additional AN/ARN-65 (V) airborne Tacan sets for use in B-58 bombers.

• **Molectronics Corp.**, Minneapolis-Moline Co.'s electronics subsidiary in Los Angeles, will produce lightweight frequency switch carrier telegraph systems for Army Signal Corps under a $2,459,000 contract.

• **Space Electronics Corp.** will conduct theoretical and experimental studies of ultra low frequency (400 cps.) and sub-surface propagation of electromagnetic waves over distances of thousands of miles. The study, sponsored by the Air Force Cambridge Research Laboratories, is one of several contracts the firm has had in the field of "earth currents."

• **Astronics Division, Lear, Inc.**, $313,953 for research and development of gyroscopes from Army Ordnance District, Los Angeles.

• **Electro-Optical Systems, Inc.**, will conduct research and development of a remote setting micro-baroswitch under a $79,668 contract from Army Ordnance District, Los Angeles.

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The SIREN Company has created affilial organization: SIREN INTERNATIONALE the network of which covers all of Europe, and would be interested in representing non-competitive American firms.

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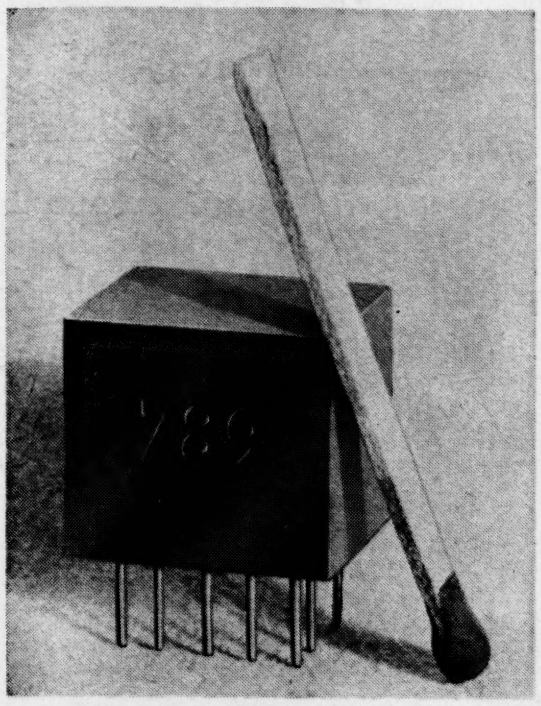
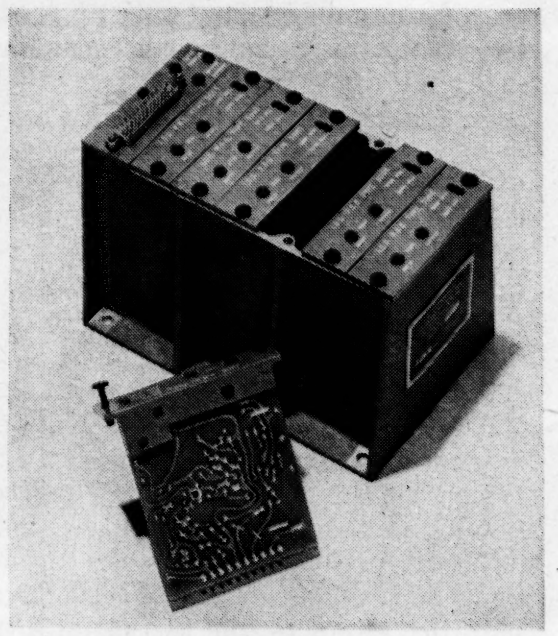
NEW AVIONIC PRODUCTS

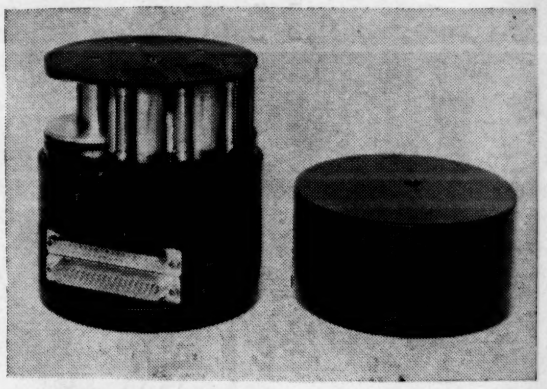
• **Subminiature logic circuit modules,** Series 789, encapsulated and transistorized, are available in complete series of digital and logic circuits including binary counters, triggers, multivibrators, gates, inverters and flip-flops. Modules measure 7/16 x 9/16 x ½ in. and weigh less than 4 gr. each. Connections are



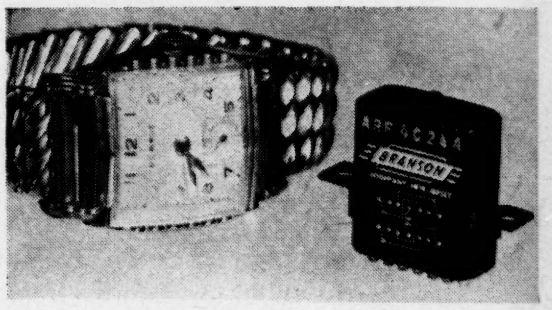
provided by means of 9 or 11-pin headers. New 789 Series is designed to meet continuous operating temperatures of MIL-E-5400C, Class 4, and environmental requirements of MIL-E-5272. Complete technical/performance data is available in Bulletin 12331 from manufacturer: Walkirt Co., 141 W. Hazel St., Inglewood, Calif.



• **Six-channel demodulator,** Type 3004, phase-sensitive, accepts input signal of up to 25 mv. rms. at 400 cps. and provides output ranging from 0 to 5 v.d.c. Gain stability and linearity are within 1% of full scale, according to manufacturer, and response time is 8 ms. Demodulator measures 4 x 4 x 6¼ in. and weighs 3 lb. Unit is designed to withstand 20g at 20 to 2,000 cps. and 75g shock for 11 ms, and operate at maximum temperature of 100C. Manufacturer: International Data Systems Inc., 2652 Brenner Drive, Dallas 20, Texas.

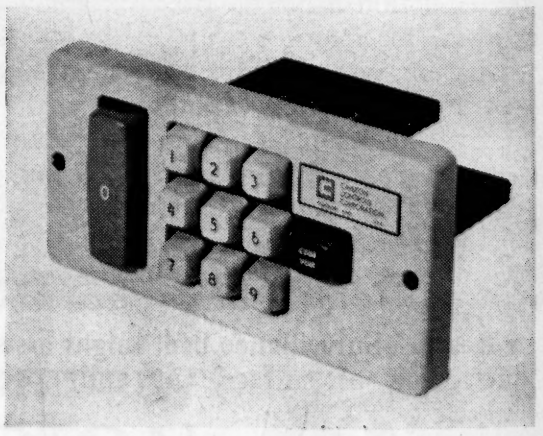


• **Miniature tape recorder,** Model TR-1875, simultaneously records 1 to 14 channels in line or interlaced. Recorder, which measures 4¼ in. dia. by 4¾ in. high, weighs 3½ lb. including full load of 150 ft. of 1-mil Mylar tape, which provides up to 16 min. recording time. Device is available with tape speeds of 1.875, 3.75, 7.5 and 15 in./sec. Wow and flutter under static conditions are less than 1%, according to manufacturer. Aero Data Manufacturing, 12780 B. Western Ave., Garden Grove, Calif.



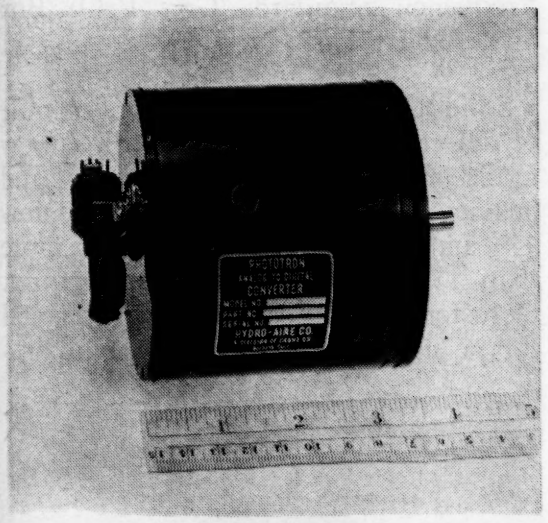
• **Miniature relay** with center-of-gravity mounting, Type AR, comes in 2PDT and 4PDT models with contacts rated 28 v.d.c. resistive load. Relay will withstand 20g vibration at 2,000 cps. at 50g shock, according to manufacturer. Operating temperature range is −65C to 125C. Relays are available with coil voltages ranging from 6 to 115 v.d.c. Manufacturer: Branson Corp., P.O. Box 234, Whippany, N. J.

• **Numerical push button station,** Model 3030, for panel mounting, provides momentary contact buttons, spaced on ⅞ in. centers. Device can be provided with any combination of two form A, B or C contacts per station, with contacts rated 3 amp, 110 v., non-inductive. Station



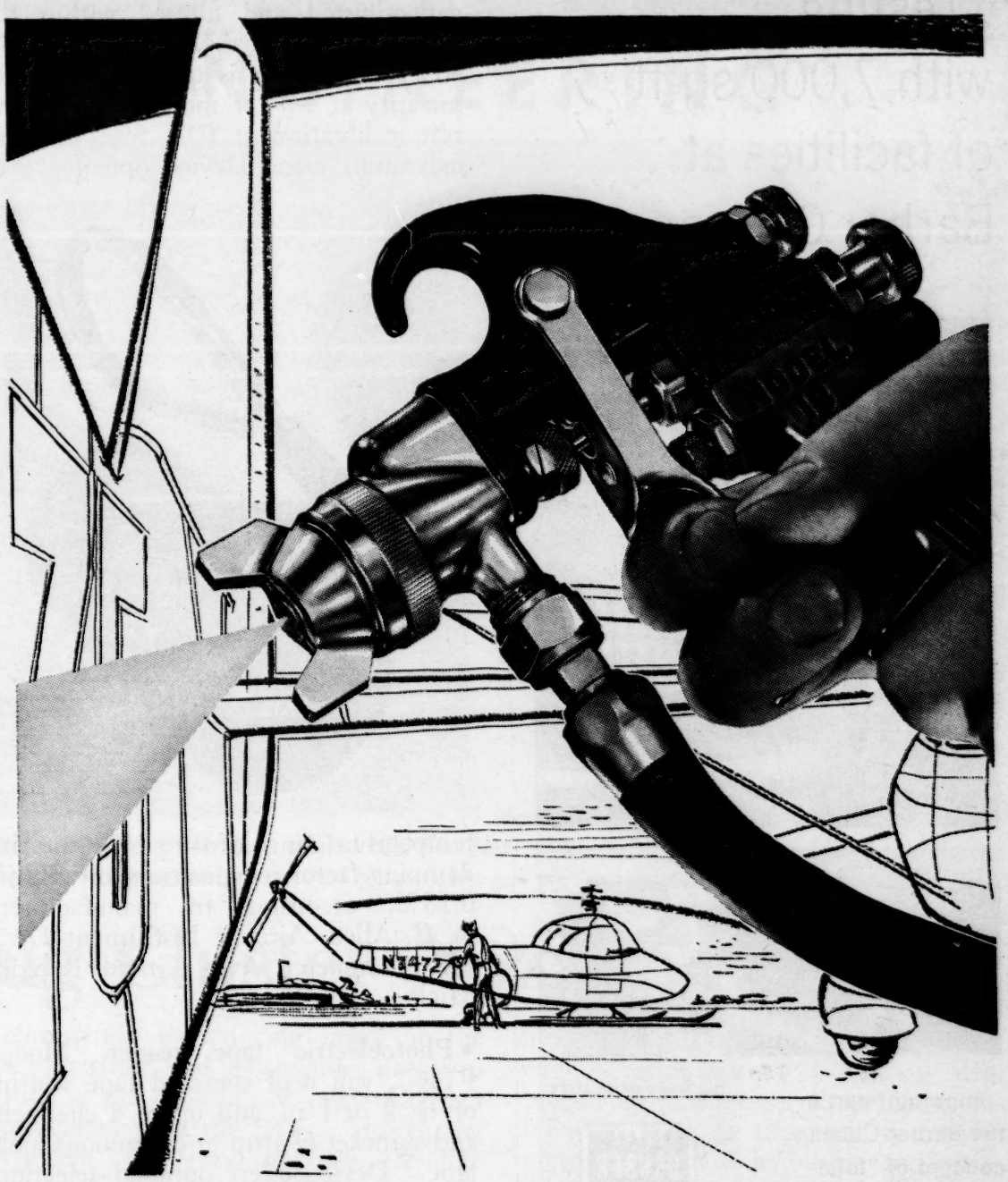
measures approximately 8 x 4 x 4 in. Manufacturer: Carlton Controls Corp., 15 Sagamore Road, Worcester 5, Mass.

• **Miniature microwave isolators,** for X and K_u band use, provide 15 db. minimum isolation at X-band, 25 db. minimum at K_u band. Insertion loss is 0.3 db. maximum, and VSWR is 1.20 maximum, according to manufacturer. The X-band isolator is 0.5 in. long; the K_u band isolator is 0.7 in. long. Manufacturer: Kearfott Microwave Division, General Precision Inc., 14844 Oxnard St., Van Nuys, Calif.



• **Analog-to-digital converter,** called Phototron, can be operated at speeds up to 15,000 rpm. at 128 counts per revolution, or 1,250 rpm. at 2,048 counts, providing sampling rates up to 45,000 counts per sec. Device operates bi-directionally, can provide both quantity and rate information and electrical zero reset is available. Device uses light beam which is interrupted by a slotted disc. It weighs 19 oz., measures 4.68 in. long and comes in diameters ranging from 2.75 to 3.5 in. Manufacturer: Hydro-Aire Co., Electronics Div., 3000 Winona Ave., Burbank, Calif.

• **Inverter-demodulator rate gyro,** operates from 28 v.d.c. input which it converts to a.c. for operating gyro motor and for exciting microsyn-type pickoff. Pickoff output is demodulated, balanced,



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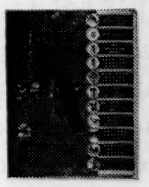

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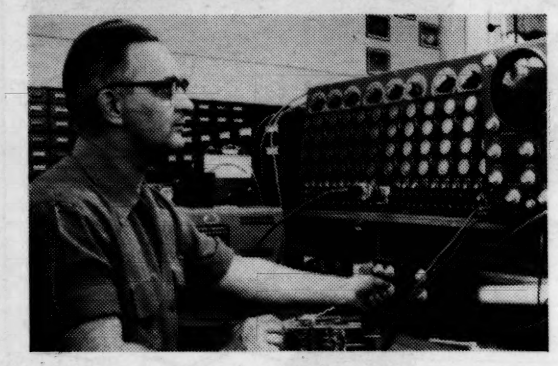

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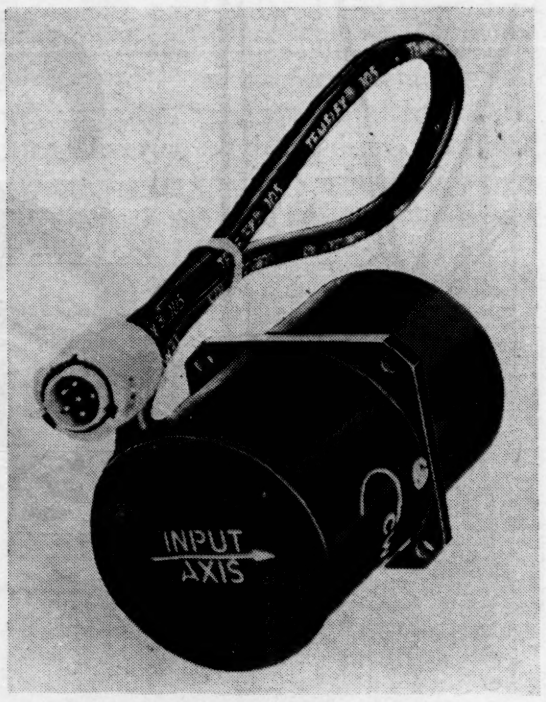
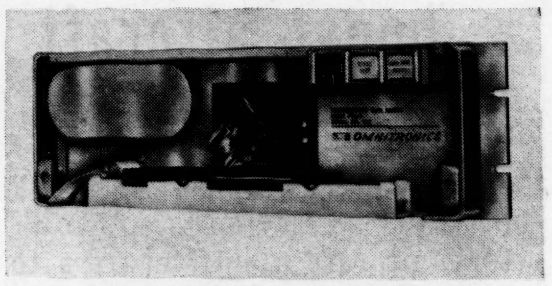
gain-adjusted and filtered within the unit to provide a d.c. output up to 12 volts. Resolution is quoted at 0.05%, linearity at 1% of maximum rate and zero calibration at 0.01 to 0.02% of maximum rate. Device operates over



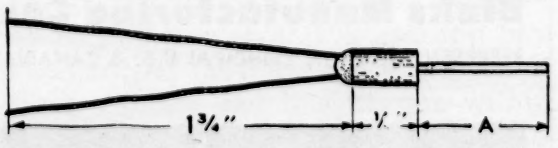
temperature range of 0 to 185F and its damping factor remains constant within 0.15%, according to manufacturer: R. C. Allen, Aircraft Instrument Div., 333 Commerce Ave., Grand Rapids, Mich.

• **Photoelectric tape reader,** Model PTR-7, will read standard tape widths of $\frac{11}{16}$, $\frac{7}{8}$ or 1 in. and up to 8 channels and sprocket of strip or continuous loop tape. Device offers optional selection of four speeds from 10 to 100 in./sec. with reading rate of up to 1,000 characters per second. Only three milliseconds is required to bring tape from a dead stop to full speed, and machine will stop



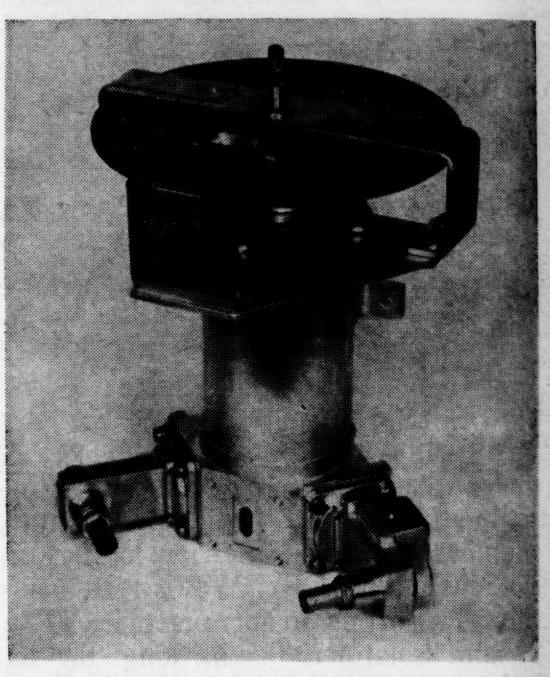
tape in less than one millisecond, according to manufacturer. Tape reader measures 19 in. x $5\frac{1}{4}$ in. x 12 in. Bulletin giving added details is available. Manufacturer: Omnitronics, Inc., 511 North Broad St., Philadelphia 23, Pa.

• **Microminiature thermocouples,** measuring only 0.014 in. in diameter, are available in several sheath materials and lengths. Response time is 13 milli-



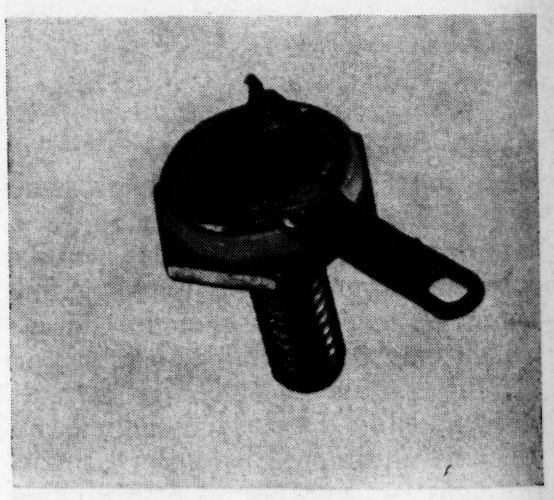
seconds in the exposed junction configuration. Units are available for operation at temperatures ranging from near absolute zero to 3,000F. Manufacturer: Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., 42 Fourth Ave., Waltham 54, Mass.

• **Dual mode discriminator** for use as a sensing element in a klystron frequency stabilization system, provides an error signal 40 times the stability of klystron alone. Discriminator, designed for operation in the 8,500- to 9,600-mc.



band, enables stabilization system to reduce klystron signal variation from unstabilized value of 0.6-1.2 mc. to a value of 15-30 kc., according to manufacturer. Frequency Standards Co., P.O. Box 504, Asbury Park, N. J.

• **Solid-state radiation detector,** capable of detecting alpha particles with energy levels of 0.5 to 10 mev., protons and heavier particles, has resolution below 4% and a signal-to-noise ratio of more than 15:1, according to manufacturer. Detector is composed of single crystal P-type silicon with shallow N-type sur-



face diffused layer. Under reversed bias of 10 to 100 v., ion pairs produced in the diode by particles striking the upper surface may be collected and amplified to give signal proportional to energy loss in the sensitive volume. Detectors are priced at $50.00 each. Manufacturer: Semi-Elements, Inc., Saxonburg Blvd., Saxonburg, Penna.

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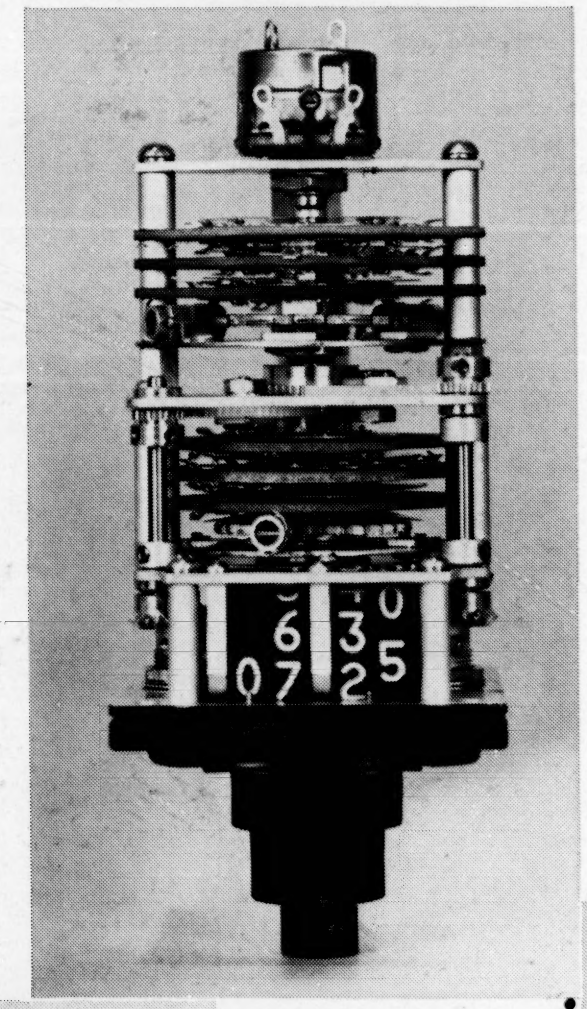

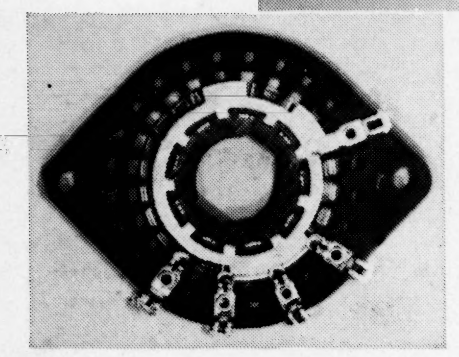

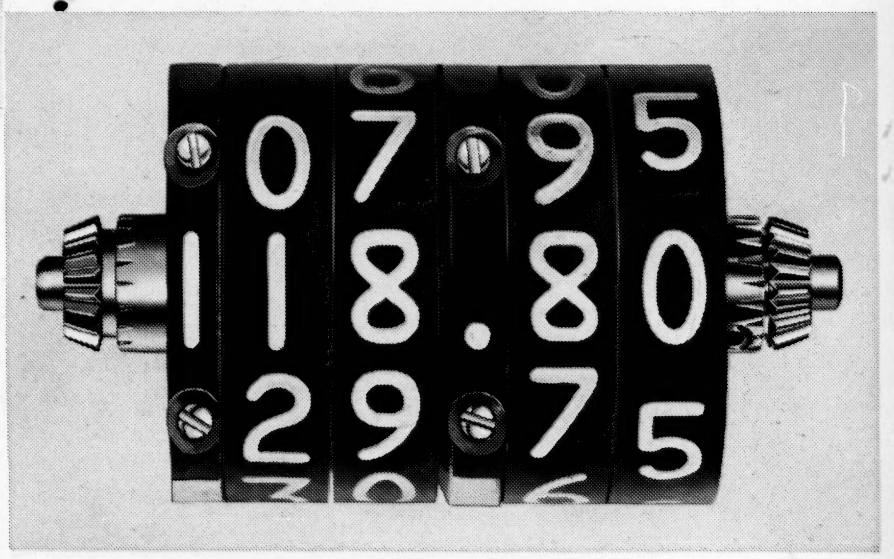

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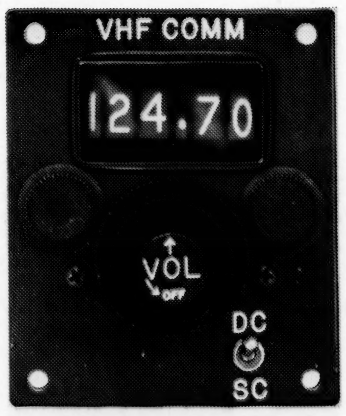

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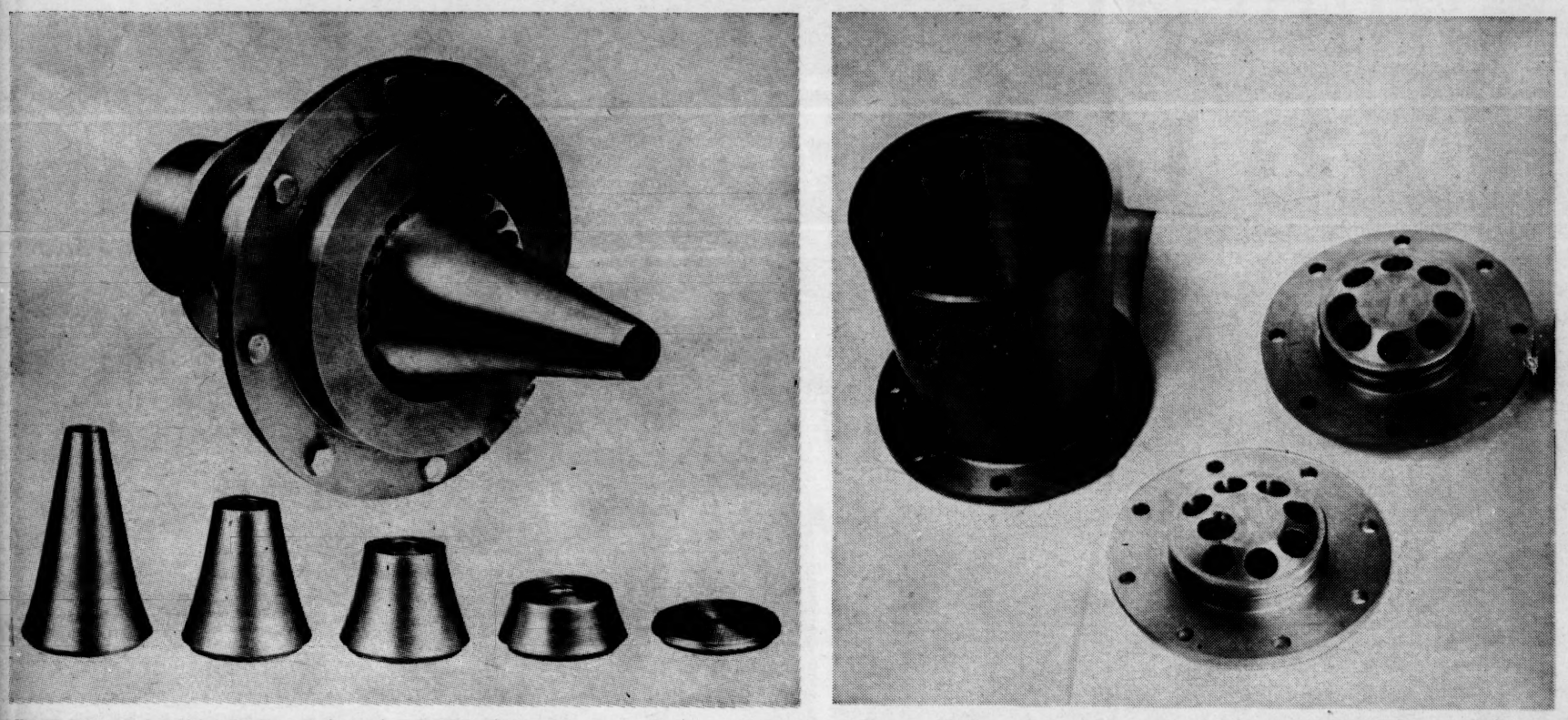


BOILER PLATE MODEL (left) of P&W's 24-unit plug cluster nozzle is used in cold flow tests with a variety of plugs truncated to different lengths. Inverted plug cluster nozzle designed by P&W has severely truncated plug (right) and uses an external skirt to turn exhaust flow.

Vectorable Plug Cluster Nozzle Tested

By Michael Yaffee

E. Hartford, Conn.—Latest development in rocket engine plug nozzle design is the highly vectorable, low cost, clustered engine concept under development here by Pratt & Whitney Aircraft Division of United Aircraft Corp.

As designed by Pratt & Whitney engineers, the plug cluster nozzle uses a number of axisymmetric rocket engines tilted toward the axis and clustered around a central, truncated plug. Individual engines, which would be small, off-the-shelf units, may be hinged at the base for vector control. Most attractive arrangements, according to P&W, appear to be clusters of from 12 to 50 engines.

This building-block design, similar in principle to General Electric's segmented engine plug nozzle (AW Feb. 1, 1960, p. 16; Sept. 5, p. 28), possesses the advantage of high thrust vector control, according to P&W, as well as all the benefits of reliability and low development and manufacturing costs associated with the use of standard proven engines. Moreover, the clustered arrangement carries "a built-in spare engine" which increases the chances for completing a mission, says P&W in answer to those questioning the reliability of a number of rocket engines operating simultaneously.

At the same time, P&W engineers claim that the plug cluster nozzle provides performance equivalent to that of an annular throat plug nozzle while eliminating or reducing many of the aerodynamic and mechanical problems such as the complicated injector design associated with the latter. The cluster concept, they say, shortens development time, permits scaling the engine through a range of desired thrust levels, and significantly reduces development and manufacturing costs.

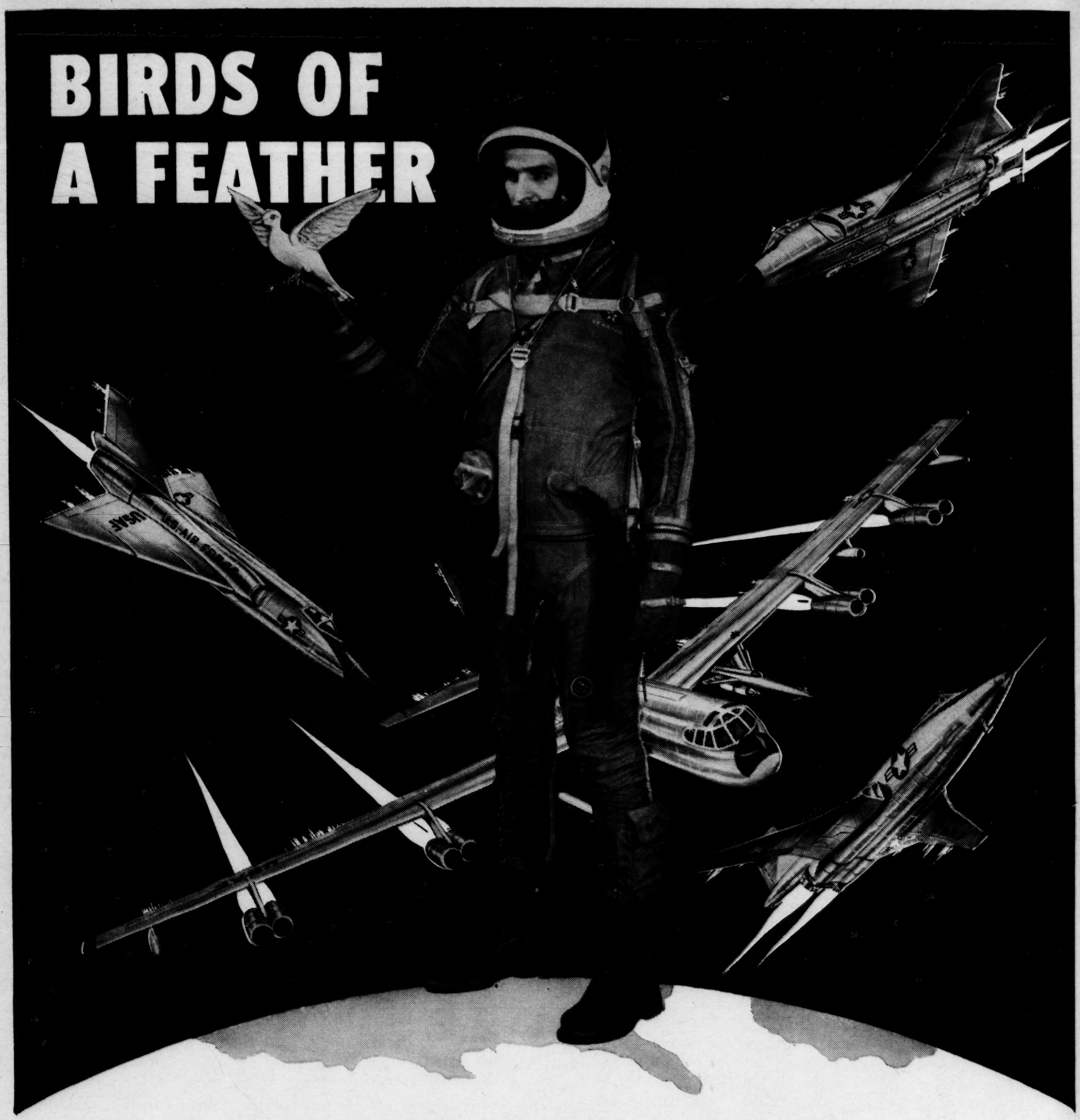
Since the plug cluster is built up of standard rocket engines, they point out, the development effort can be devoted to one small motor which already may have a development background and so, among other things, not require new test or production facilities. Instead of having to static fire an entire large engine, individual units can be static tested, thereby saving many thousand gallons or pounds of propellant. Similarly, individual motors can be tested to destruction and replaced without having to destroy an entire, new, multi-million dollar engine.

Pratt & Whitney engineers have built a number of cold flow plug cluster models and have tested them over a wide range of nozzle pressure ratios. The models are basically boiler-plate units which, in place of individual nozzles, have several nozzle openings drilled through a single piece of metal stock threaded in the center for the attachment of different size plugs. For comparison data, P&W also designed and tested an all-external expansion plug nozzle with the same area ratio and an annular throat.

In addition, P&W engineers have built and tested a hot flow, plug cluster model consisting of four individual engines and nozzles tilted 30 deg. toward the centerline. Propellant combination used in this unit is unsymmetrical dimethyl hydrazine and nitrogen tetroxide at a chamber pressure of 300 psia. The hot flow model was fired for the purpose of studying the transient characteristics of thrust vector control obtained by throttling of the individual units.

From their experience and testing to date, P&W engineers have arrived at the following conclusions:

- **Designed with closely spaced** individual nozzles with properly faired contours, the plug cluster nozzle provides performance levels and characteristics identical to a comparable annular throat plug nozzle with internal plus external expansion.
- **Extreme truncation of the plug** causes little or no loss in performance until a very short length is obtained, while eliminating the weight and cooling problem of long plugs. With only a short length of plug, the blunt base region still provides close to 100% of theoretical performance.
- **Blunt base of a severely truncated** plug causes the nozzle flow to detach from the plug contour and form a free boundary which is defined on one side by atmospheric pressure and on the other by the pressure existing in the separated base region. The free boundary is directed toward the axis and adjusts itself to the axial direction through a complicated mixing and trailing shock system, resulting in a base



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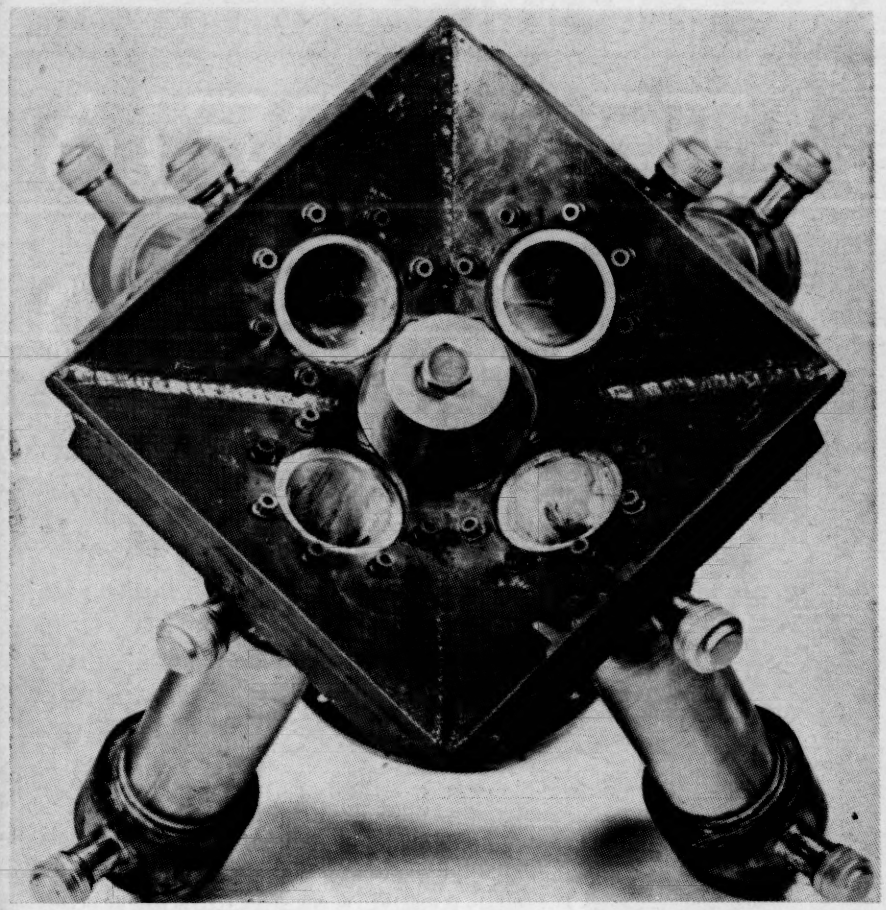


HOT FLOW MODEL of plug cluster nozzle is used by P&W engineers to study thrust vector control obtained by throttling. Plug is truncated to approximately 10% of its "ideal" length. Unit is fired (right) at a chamber pressure of 300 psia. using a propellant mixture of unsymmetrical dimethyl hydrazine and nitrogen tetroxide.

pressure contributing to nozzle thrust.

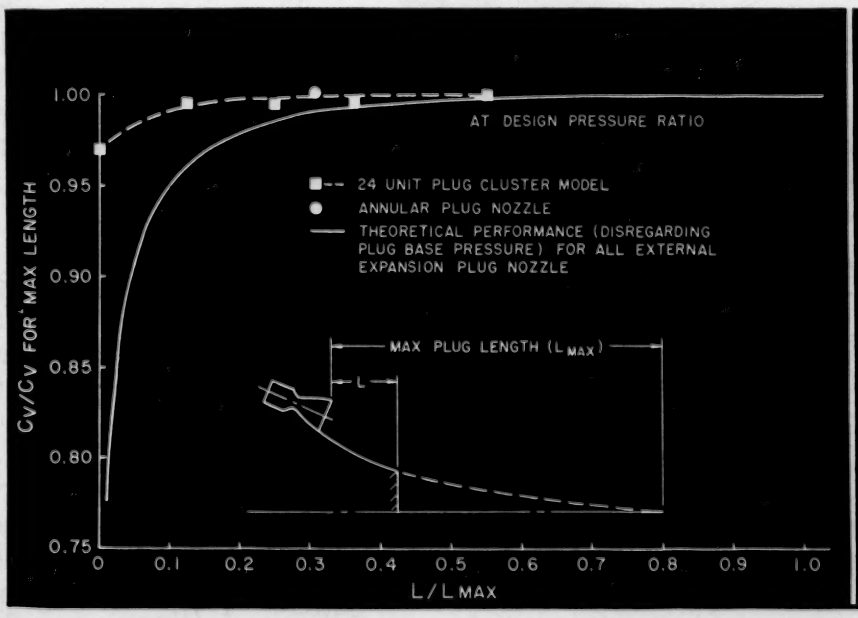
• **Thrust vector control can be** accomplished in several different ways—gimbaling individual motors, gimbaling the plug, throttling individual units. Most of these methods, however, were found to have some serious drawbacks. Throttling, for example, reduced over-all thrust level. Gimbaling the plug or large nozzles required heavy and complicated actuating devices. On the other hand, P&W engineers recently found that small, hinged, individual units with a short fixed plug avoided all these problems and appear to produce the greatest amount of side force for vectoring with the least expenditure of effort or impairment of over-all performance.

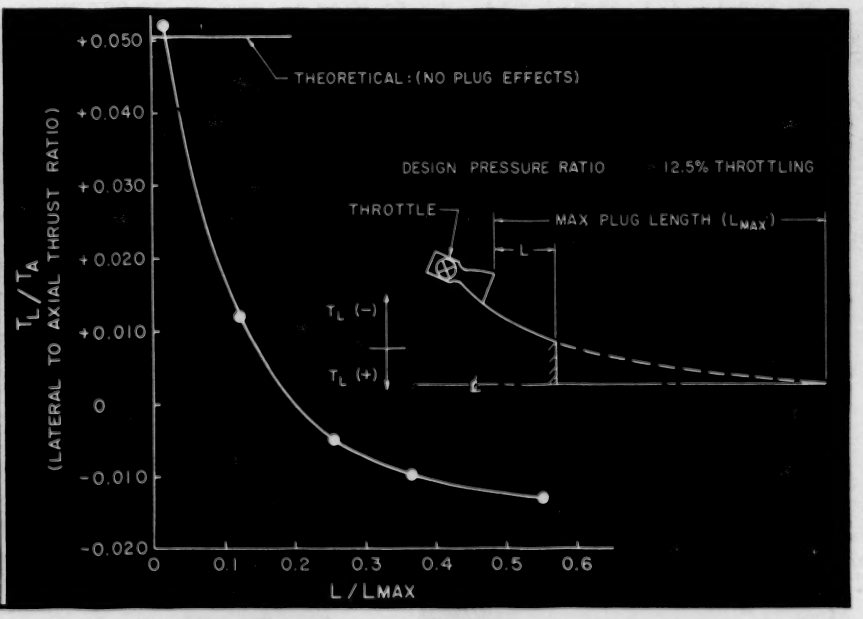
• **Shock vector control by injection** through the plug looks attractive for some applications. Use with solid propellant rocket engines was one possible application mentioned.

• **Plug cluster nozzle concept** also appears suitable to extreme altitude performance where the exhaust flow is turned 90 deg. or more to achieve full expansion. This design, which P&W refers to as an inverted plug nozzle, is similar in principle to the E-D (expansion-deflection) or Rao nozzle under development by Rocketdyne except that P&W plans call for a cluster of several small thrust chambers instead of one large one. The inverted plug cluster design can be used where the exhaust flow is turned less than 90 deg. as well as in a reverse flow design requiring a turning of more than 90 deg.

• **Plug cluster nozzles** seem well suited to both liquid and solid propellant rocket engines and are expected to find applications with both types. Regular plug nozzle, rather than the clustered plug design, will probably find use in future nuclear rocket engines.

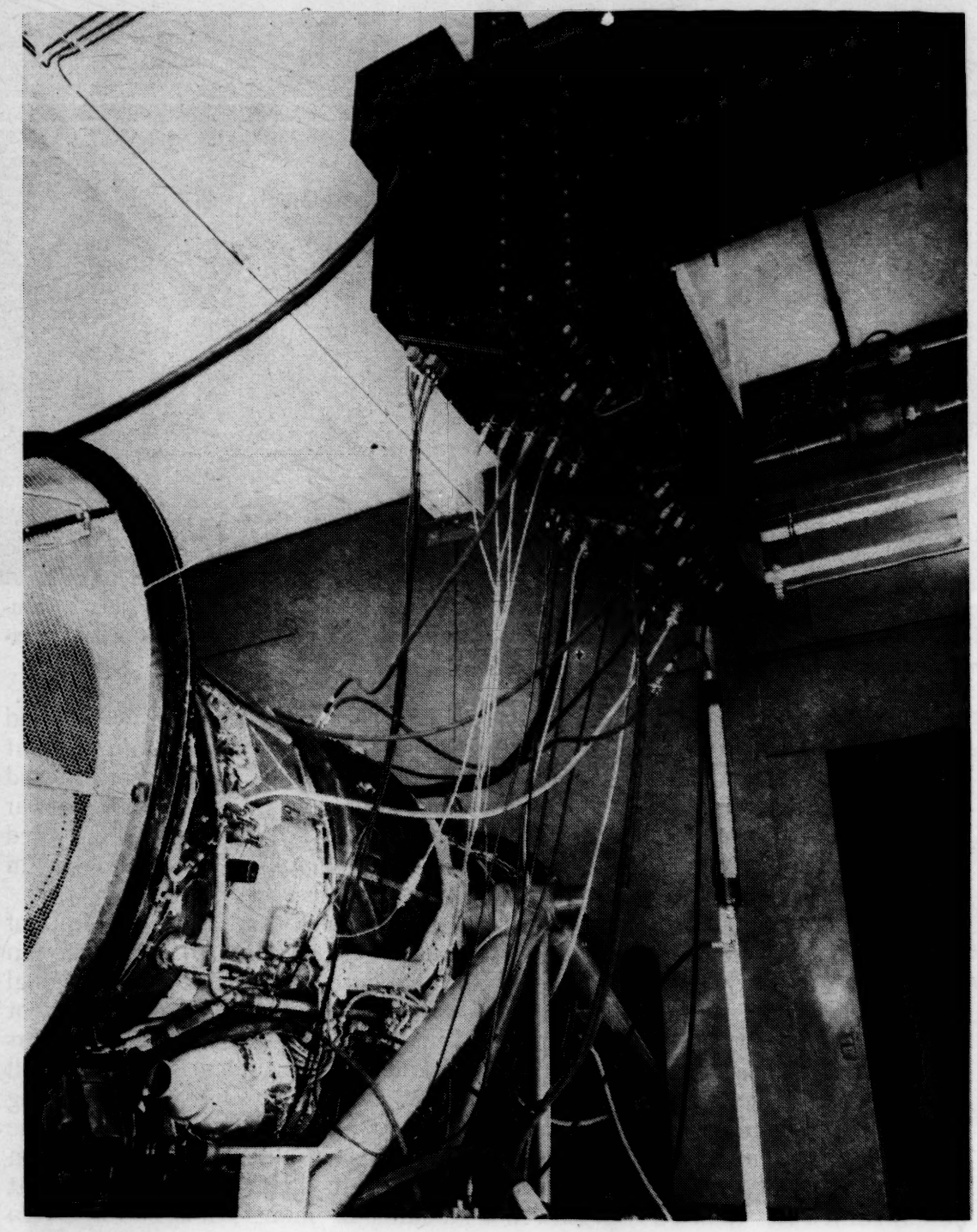
Despite the significant amount of work that remains to be done in developing a practical, operational rocket engine plug nozzle—clustered or otherwise—Pratt & Whitney engineers generally feel confident that they will come into use. Greater operating efficiency of the plug nozzles over the wide range of altitude conditions from sea level to space will save sufficient amounts of money, it is believed, to make these designs an essential economic ingredient of space planning.



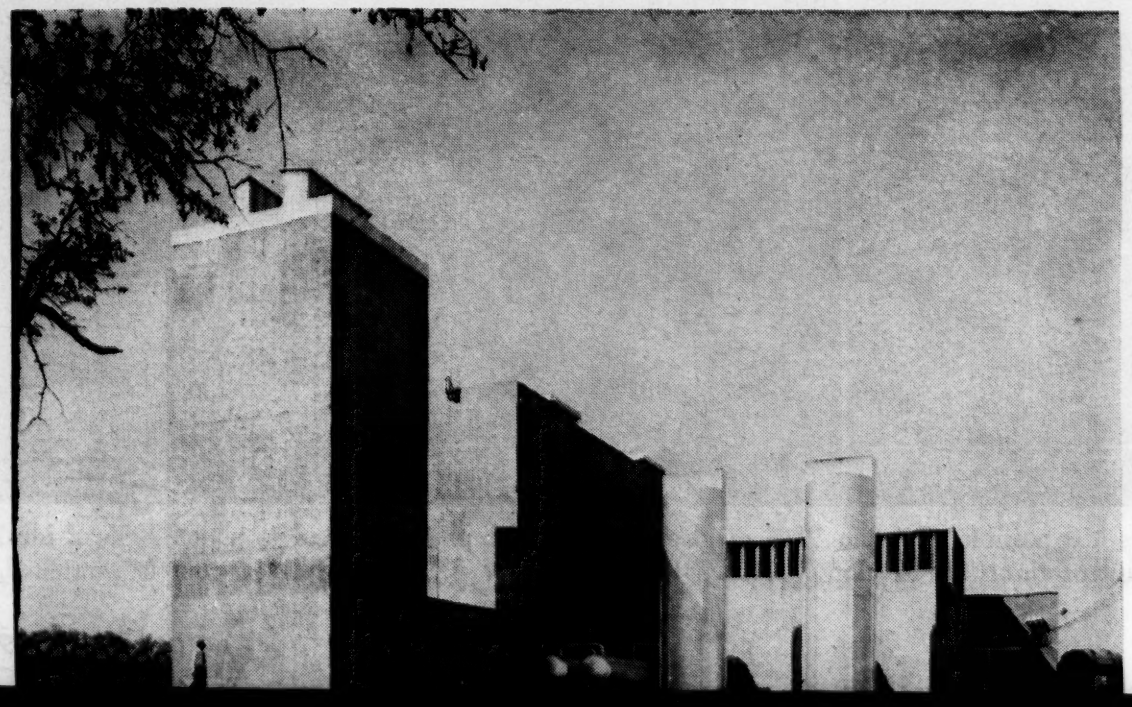


GRAPH of 24-unit plug cluster nozzle indicates it is possible to obtain 98% of ideal thrust with a plug truncated to about 90% of ideal length. Graph (right) shows that given amount of throttling develops greater lateral forces (for vector control) as plug is shortened.

Texas Firm Expands Airline Jet Overhauls



JUNCTION BOX neatly groups all necessary engine-to-control-room connections and is designed so harnesses for various types of engines cannot be installed incorrectly. New test cell at right (below) is capable of taking engines up to 30,000-lb. thrust; two earlier cells at left were installed by Southwest Airmotive for Allison J33 turbojets.



Dallas, Tex.—Southwest Airmotive Corp.'s investment of $2 million on a new jet engine overhaul and test facility expansion program, aimed at exploiting the potential of airline turbine engine business as well as military work, shows continued signs of success.

The new engine test facility provides backup to the company's overhaul shops to give this major business aircraft service firm the capability of handling turbojets up to the 30,000-lb.-thrust class. Shop equipment setup has advanced to a point where Southwest Airmotive is in a position to expand to advanced turbojets—or to handle a variety of small jets, such as the types that will be moving into the high-speed business aircraft fleet over the next few years, with relatively small additional tooling investment.

Current Contracts

It currently has contracts from four major carriers to do overhauls on their Pratt & Whitney JT-4s (J75): for Braniff's 707-227s, Eastern Air Lines' and National Airlines' DC-8s, and for Northwest Airlines' DC-8Cs, while the latter carrier is building its overhaul facilities. Negotiations are currently under way with a fifth carrier for overhaul of its turbojets and accessories.

Due to changing overhaul periods on these new jet engines, delivery of engines to the facility have been somewhat erratic. With overhaul times stabilized, Southwest Airmotive expects to be delivering completely overhauled engines on a one-per-working-day schedule in March. From last July, when the shops began working on these airline turbojets, the company has delivered 75 engines.

Including military jet engine overhauls—Southwest Airmotive is sole source for USAF and Navy on J33s, J35s and J47s—approximately 100 turbojet powerplants are going through its overhaul shops here monthly.

Engine Turnarounds

Engine turnarounds to airline customers have been actually better than originally guaranteed. On the average, turnaround time is approximately 14.6 working days as against the 17 days forecast.

This quantity overhaul rate, provides an even production flow enhancing the benefits obtainable from a large line and is reflected in rapidly building up workers' learning curves because past experience has been a major factor in

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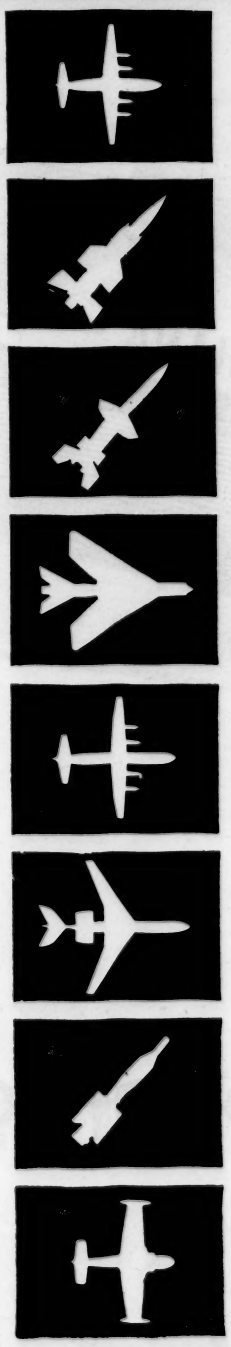

VISCOUNT

VANGUARD

VC 10

BAC 107

SUPERSONIC AIRLINER PROJECT

T-188

CANBERRA

LIGHTNING

TSR-2

JET PROVOST

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TGA BAC21

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SECOND GENERATION

VC10 projecting the

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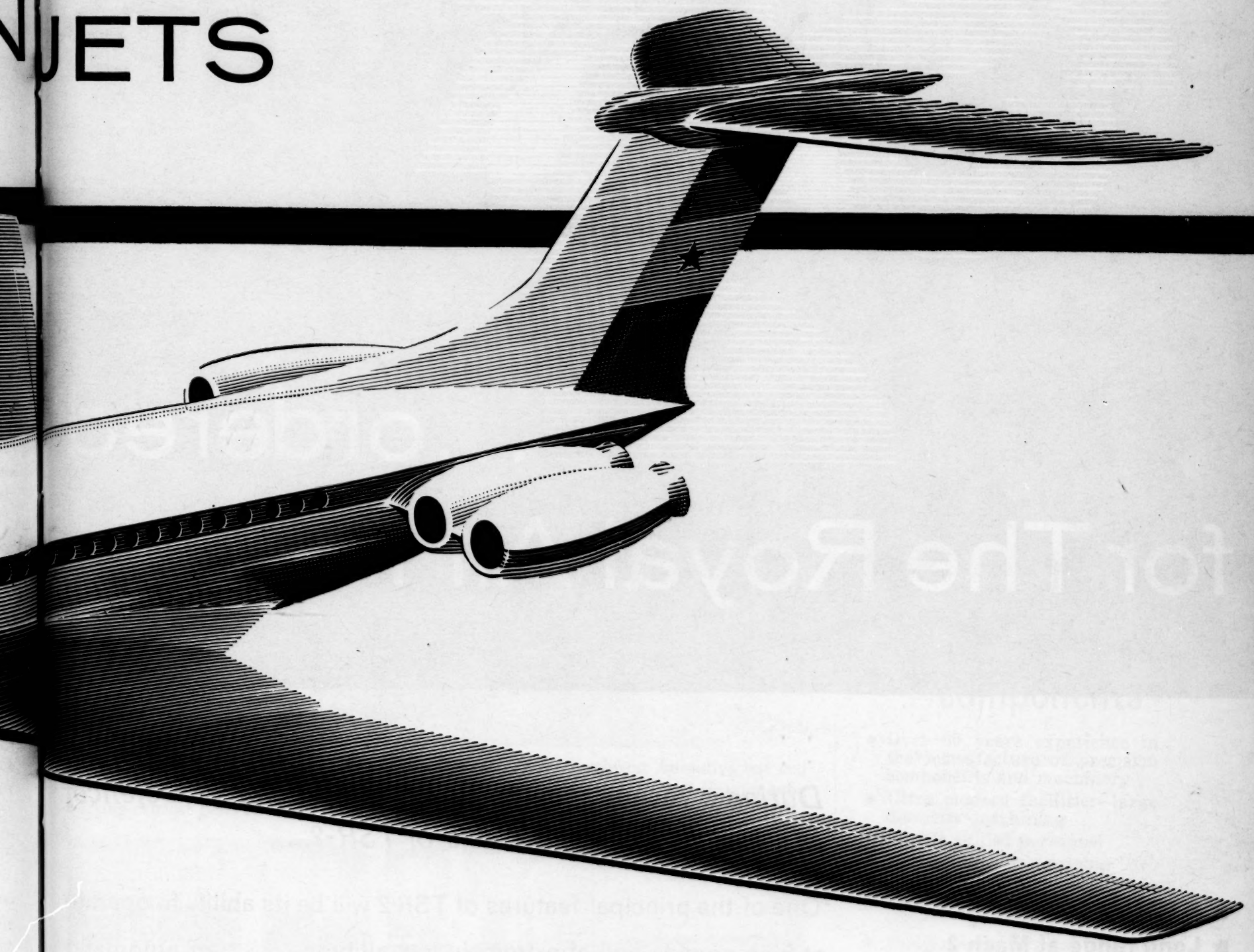
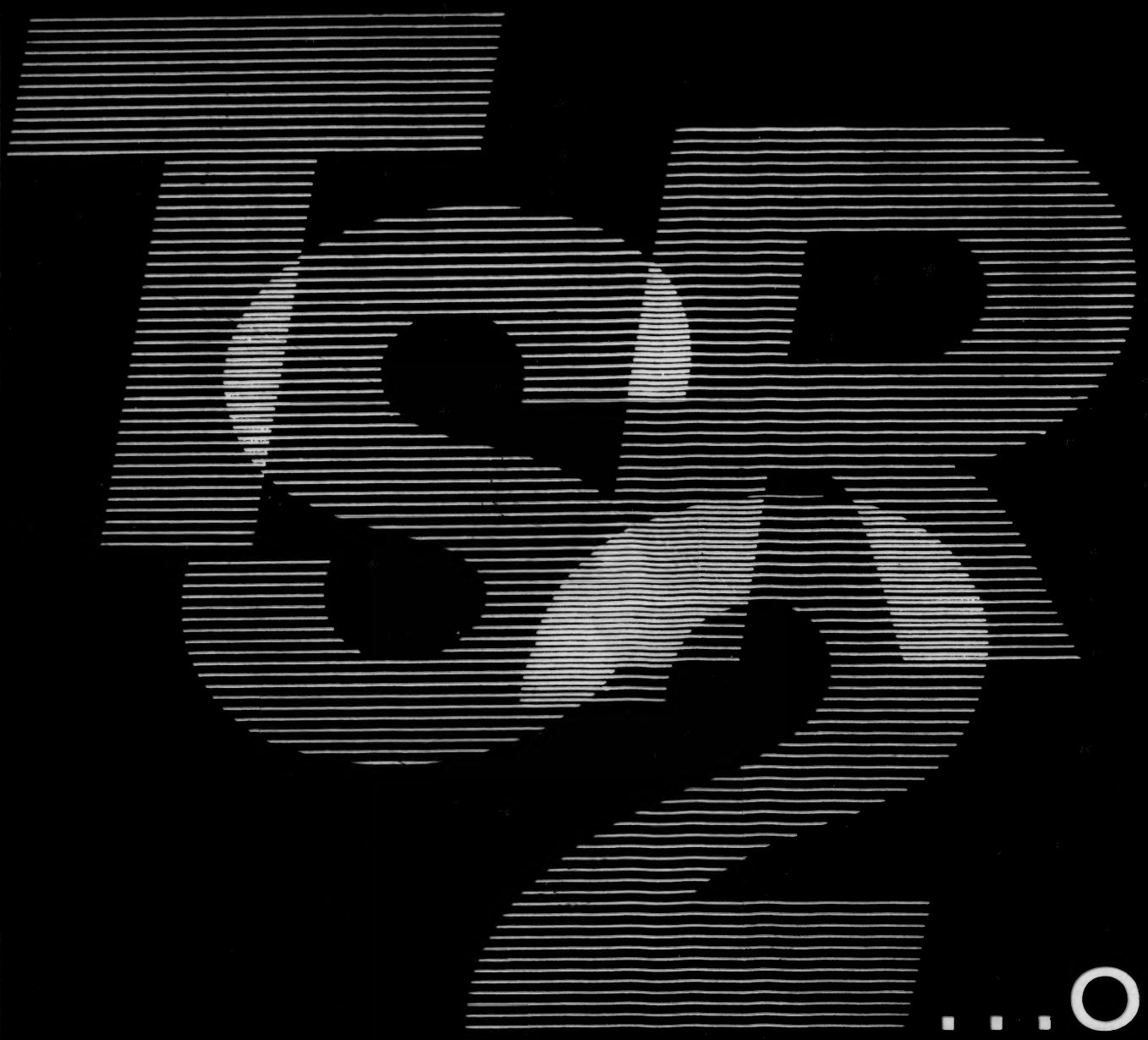


Clean-wing shape of the future

AIRCRAFT CORPORATION



...ordered

for The Royal Air Force

During a recent speech, Britain's Minister of Defence, Mr. Harold Watkinson, said of TSR-2...

- **STOL**
- **Long range at Mach 2 or better**
- **Wide range of weapons**
- **Great flexibility of roles**
- **High accuracy navigation/attack system**

'One of the principal features of TSR-2 will be its ability to operate at high speeds and at extremely low altitudes .... an automatic terrain following device will enable the aircraft to approach its target beneath enemy radar cover. It should be practically invuinerable to all known forms of counter-attack .... As far as is known, this low altitude performance is not matched by any other aircraft in the world at the present time.'

TSR 2

Powered by Bristol Siddeley Olympus Turbo-jets

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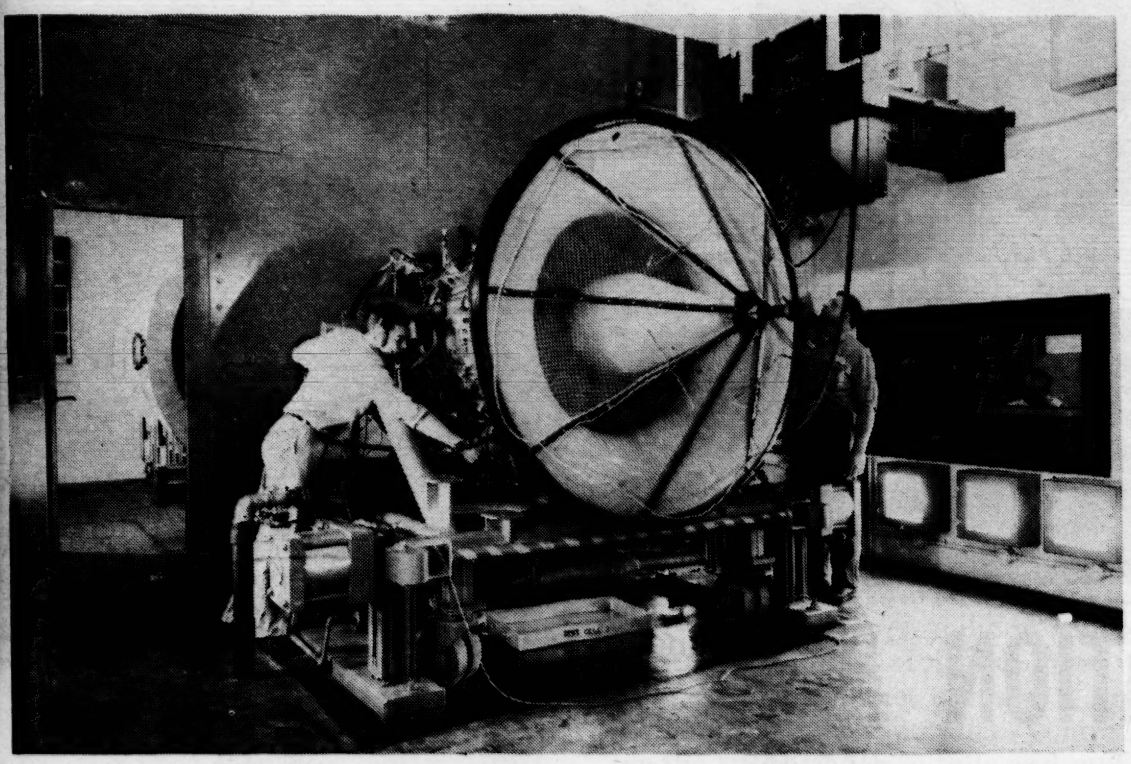
airline customers accepting the basic economics possible in farming out the new large turbojets, rather than making heavy capital expenditures required in construction and tooling for conversion from their present piston facilities.

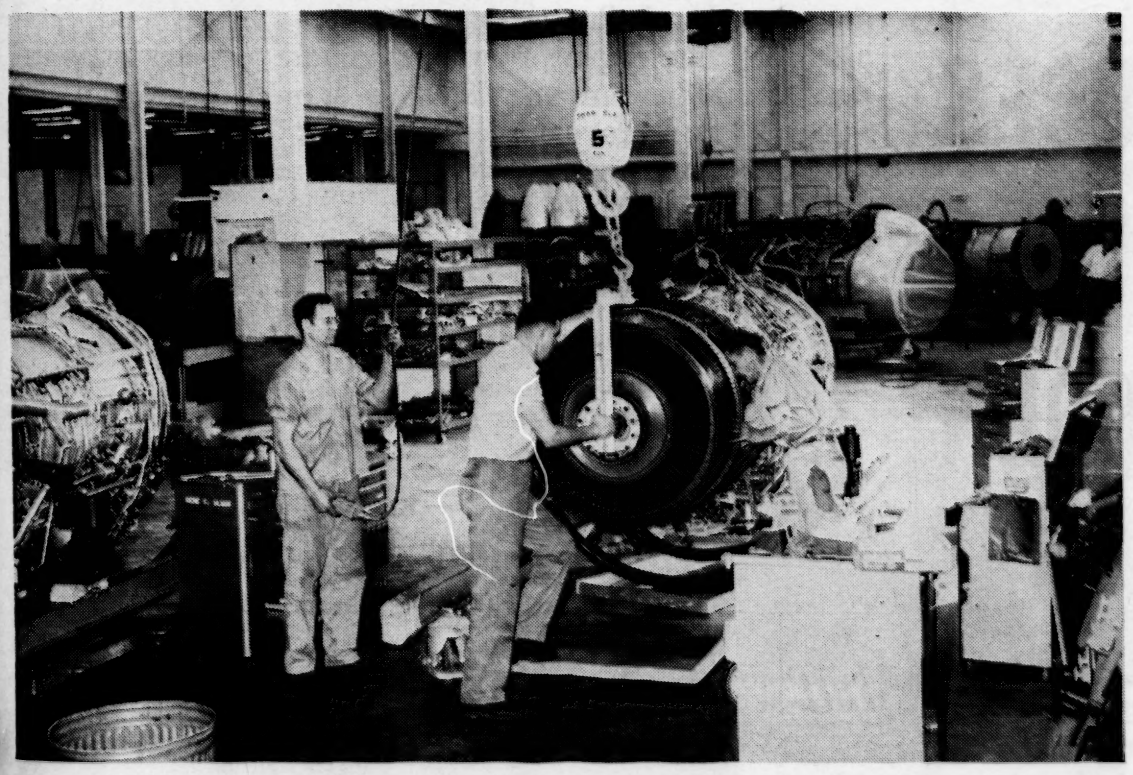
When these capital expenditures plus operating costs and interest on money invested are calculated, indications are that Southwest Airmotive can overhaul turbine engines at approximately the same cost for the largest carriers—for others, particularly those with smaller jet airliner fleets, whose workload would be considerably smaller, the service company can do it less expensively, it believes. The basic reason is Southwest Airmotive's shop facilities, plus high production rate permitting amortization of engine costs over a large number.

As an example of amortization costs facing an airline operating a mixed jet and turboprop fleet—JT-4s and Allison 501s—and assuming it is generating some 27,000-hr. engine time a month on the basis of 250 hr. per airplane, if an overhaul time of 1,500 hr. with an 80% completion factor for the monthly utilization total is attained, some 22.5 engines would be destined for overhaul each month. Based on a seven-year amortization life for the powerplants, this would amount to $1,822 per engine, not including product improvement costs. Extending this amortization to 10 years, cost would be $1,367 plus a greater charge for product improvement.

To set up the operation, plus tooling covering this overhaul, would entail expenditure of nearly $3 million, according to conservative estimates, without figuring obsolescence and facilities maintenance costs, or the tooling required



PRATT & WHITNEY JT-4 (J75) receives final check in new Southwest Airmotive test cell prior to run. Engine is hooked up to single junction box (upper right). Augmentator tube carrying exhaust gases to silencer is on tracks behind steel baffle wall.



MINOR OVERHAUL and hot section inspection is conducted on an airline JT-4 engine.

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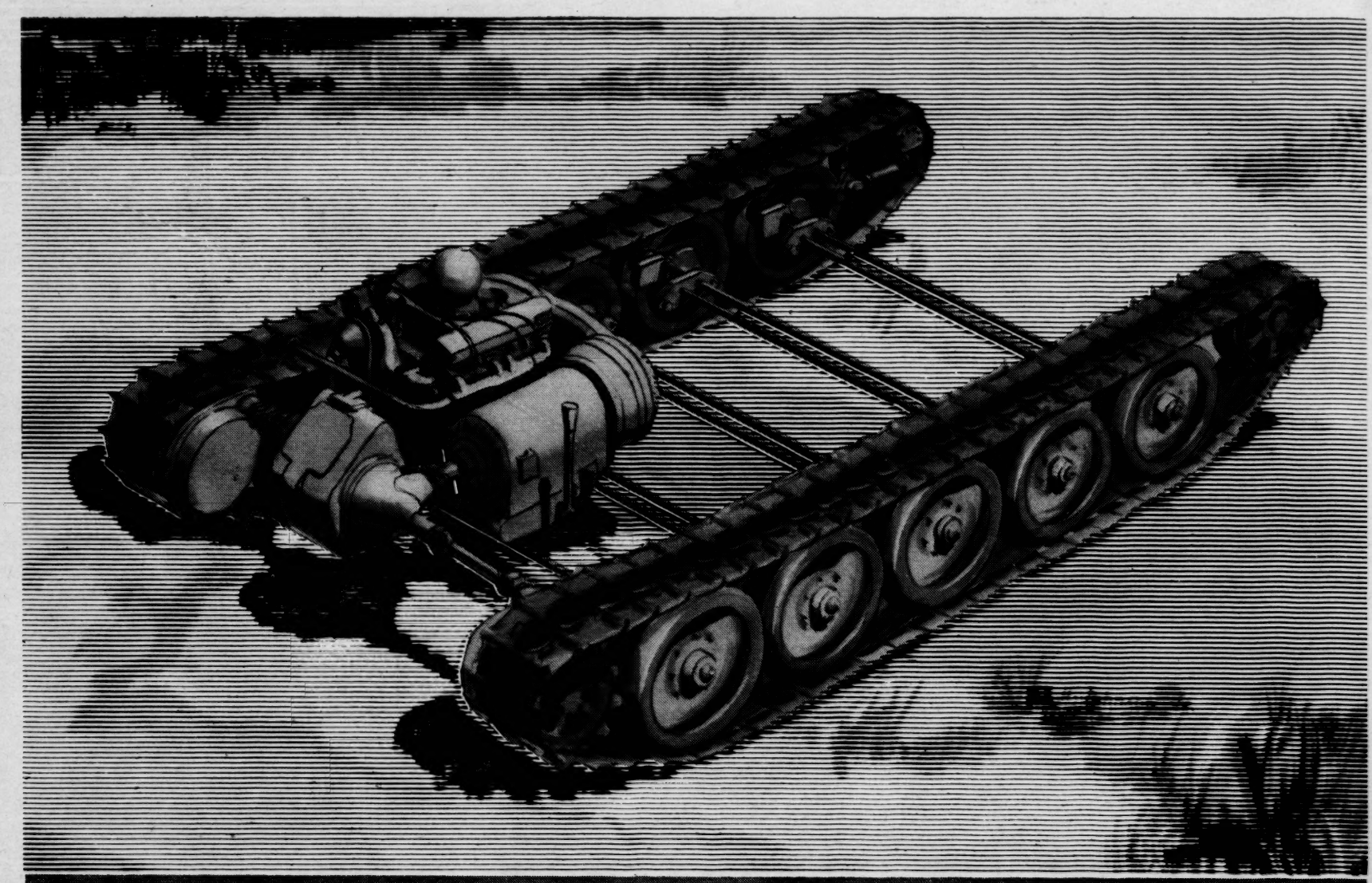

STANDARDIZATION CUTS R & D COSTS AND REDUCES MILITARY LOGISTIC BURDEN

Food Machinery and Chemical Corporation, working closely with the Ordnance Tank Automotive Command and the using forces, has put the standardization idea to work.

A prime example is the modern Army's multipurpose vehicle family. Based on the M113, an entire family of vehicles ranging from armored personnel carriers to unarmored missile carriers has been developed that uses the same engine, power train and suspension as interchangeable components. This standardization saves research and development dollars, adds production economy, and eases logistic problems in field operation.

Take advantage of these cost saving factors in planning your mobile GSE equipment. Call in FMC engineers at the concept stage of your project.

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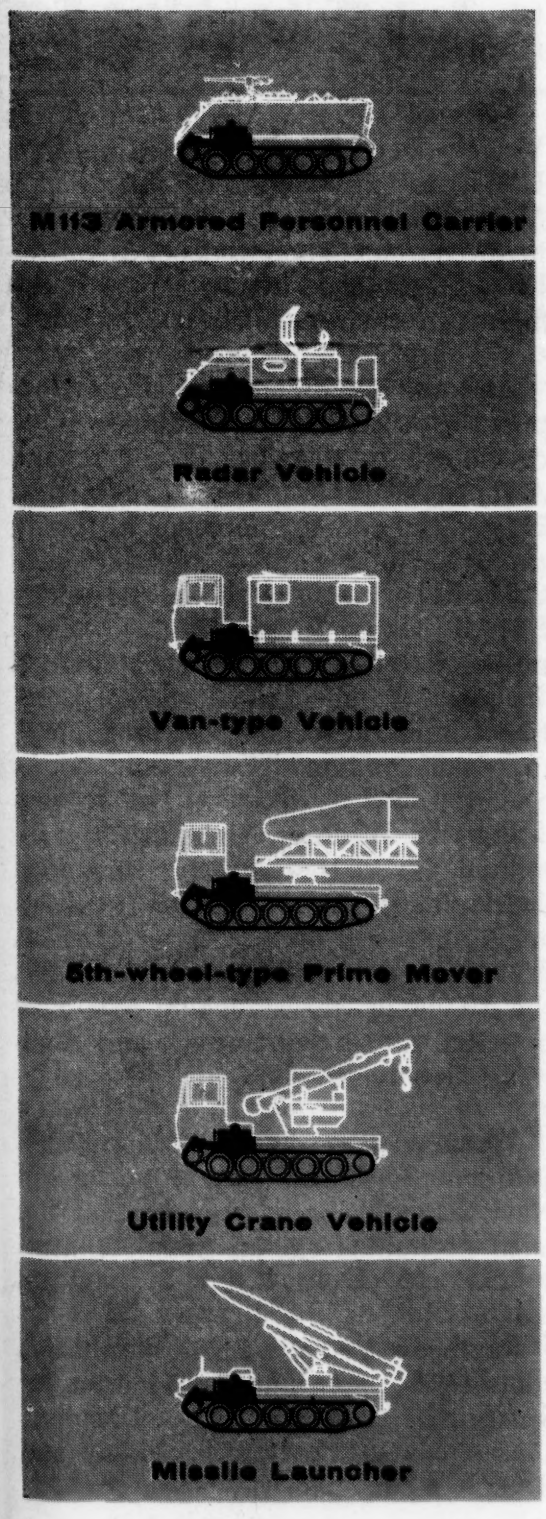
Illustrated below are just six of the operational or proposed adaptations of the standard multi-purpose vehicle family. All feature full track suspension to insure full off-road mobility on any terrain. Vehicles can be amphibious, air transported and parachute dropped.



to handle engine improvements. Southwest notes that in five years of overhauling J33s, 20% has been added to its tooling costs as a result of improvements on this already proven and large-scale-use engine. Monthly amortization charges on the loan contemplated for providing the facilities needed to handle the engine quantity noted, at 5% interest would cost over $30,000 on a 10-year period–for seven years it would amount to approximately $50,000.

Tooling Life

Southwest's experience in more than five years of military engine overhaul, during which 9,000 engines have gone through its shops, is that it is "awfully hard" to get 10 years out of tooling used in this work because of obsolescence.

Indications are that the company has developed its facilities to the position where additional engine types will require only some $200,000 expenditure to handle the General Electric J79. To handle advanced versions of the J57, such as the turbofan, would entail only some $50,000 additional costs, according to the service company. Facilities also would be capable of working on the Lockheed JetStar's JT-12 turbojets with an additional expenditure of some $25,000 in additional tooling.

Southwest Airmotive's approximately $2-million expenditure on jet facilities expansion was planned so that much of it is applicable to current military J33, J35 and J47 engine overhaul work. And despite a drop-off in business of about 50% in this work in the new fiscal year, due to change in military requirements, the timing of its readiness to handle airline turbojet overhaul is such that the $2 million in current contracts for the latter work will fully and profitably fill the gap that would have occurred otherwise.

Key feature of the program has been design and construction of a new engine test facility especially tailored for the current and next generations of turbojets. Costing approximately $500,000, the test cell is capable of being expanded to double current capacity by taking out one wall, so that adjacent engine-run facilities can be added. Power services and other test block requirements are already planned to serve such additional capability.

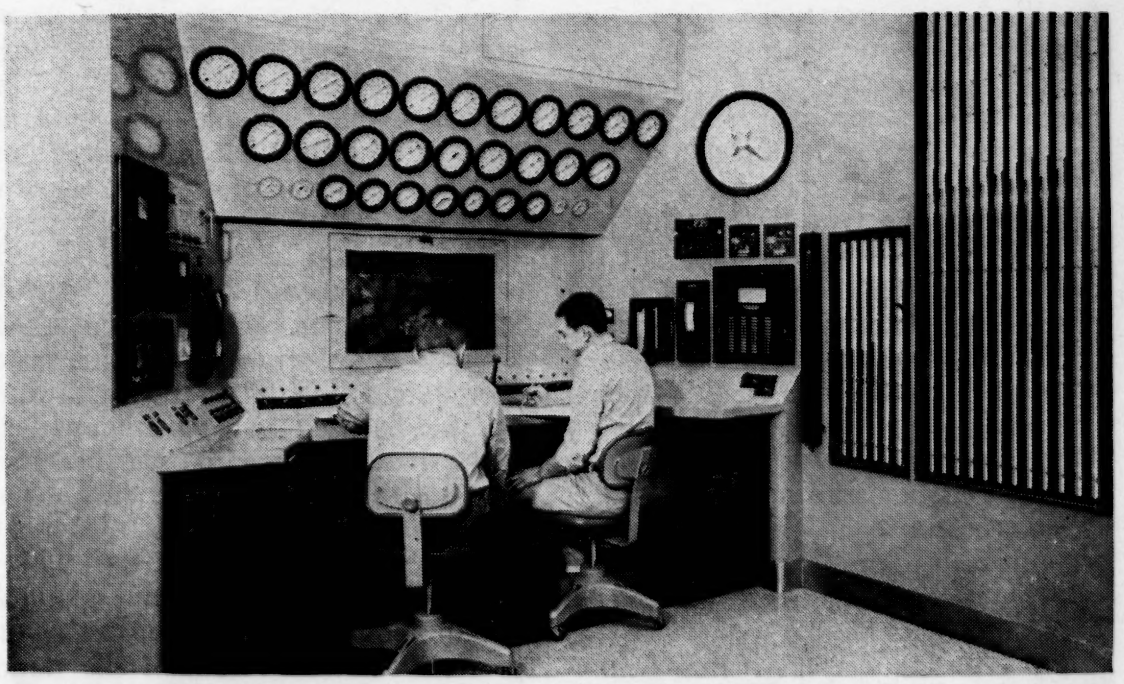
New test cell, adjacent to current pair of engine cells, measures some 116 ft. long, with maximum height of 52 ft. to the top of the industrial acoustics silencers, which are completely concrete-encased to reduce engine noises to approximately 100-db. level. Outside the cell is a water tank for coolant purposes if afterburner engines are run; also air storage for engine starting purposes.

Isolated Test Cell

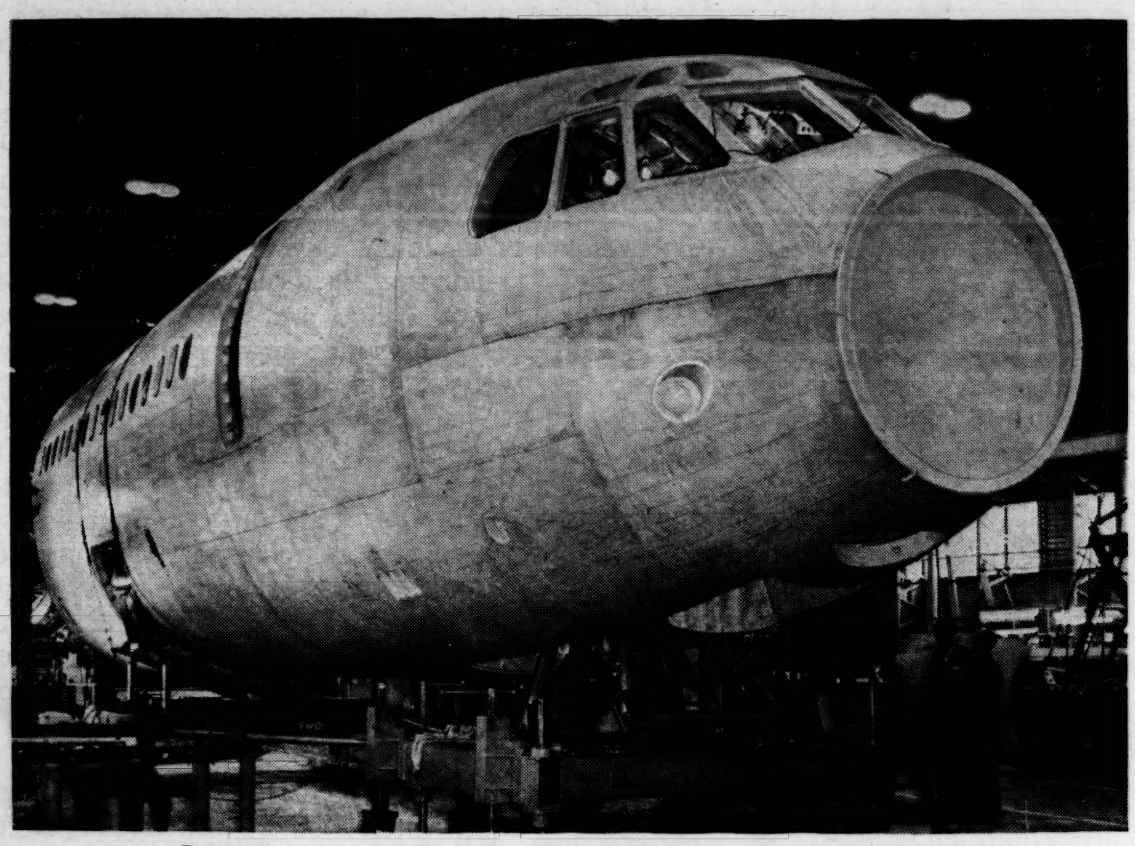
The interior of the test cell is isolated from the rest of the building, which also houses a shop area, by having a hallway encircle the test area, serving also as a buffer to reduce noise transfer. Interior of the cell, where the engine is installed, is noticeably free of wiring and plumbing, this being concealed in the walls and floors and feeding into a junction box where engine hookup is performed.

Engine, rigged for testing, is wheeled into the cell on a special dolly, which is connected to the stand, then hydraulically raised to the proper height, still on its dolly. Connections are then made from the engine to a junction box designed here, which has all hookups clearly labeled for each type of engine, with fittings planned so that appropriate connections cannot be improperly made. Receptacles are provided for the J33, J35, J47, J57, J75, JT-3 and JT-4.

Doors atop the test cell, operating from the control room, provide primary



CONTROL ROOM of new test cell has all plumbing concealed behind removable panels. Engine controls also are mounted on removable panels so that only specific controls for engine type under test are presented, thereby lessening clutter and possibility of error.



Vickers VC.10 Fuselage Assembly

Completed forward fuselage assembly of the Vickers VC.10 intercontinental jet transport is installed in the fuselage join-up jig in the Vickers-Armstrongs Aircraft plant, Weybridge, England. Aircraft, to be powered by four Rolls-Royce Conway RCo. 42/2 bypass engines giving 20,250 lb. thrust each, is slated for BOAC service in 1963 (AW Oct. 31, p. 43).

air to feed the engine being tested and secondary air that cools the augmentator tube, behind the engine stand, which takes exhaust gases up to the silencer. The baffle wall separating the engine from the augmentator tube portion of the cell makes it possible to maintain any desired pressure differentials between air supply to engine and augmentator; thus it is unnecessary to make corrections in the test for front and rear pressure differentials as is usually the case in conventional cell design.

The engine augmentator tube is on tracks behind the baffle wall and is adjustable. Aft section can be unbolted for afterburner operation.

A feature of the control room is the use of custom-made panels, designed by Southwest Airmotive personnel, tailored to each type of engine under test. Idea for having an individual control panel for each engine type is that this provides a "clean" work area with just the controls required for the test being made, rather than attempting to design one panel applicable to all engines, which might present a "forest" of handles and switches with the possibility of inadvertently operating controls improperly, particularly in an emergency.

The control room, like the cell itself, is noticeably clean of external wiring and plumbing, this being carried behind quickly removable wall panels.

Provision for receiving national standard WWV time signals permits convenient calibration of digital readout equipment on engine rpm. and check-out of equipment without having to remove it for calibration. The cells are shut down every 30 days for checkout of all equipment and calibration to tight standards. All readouts have to fall within ½ of 1% of their original calibration for all three cells.

Calibration of a cell can take 10 days using a special calibration engine on which all performance is known so that cell equipment can be checked out.

James May, manager of turbine-test, in the facility located near Amon Carter Field, pointed out that having shop facilities capable of minor repairs adjacent to the cell provides several important service benefits in engine overhaul. For example, engines that are received from overhaul and run through a test and show a discrepancy can be studied by test cell and shop personnel while the engine is undergoing test and the equipment is defining the problem area. It is also possible sometimes for shop personnel to partially pull down engine parts for rework, leaving the main portion on the stand, thus speeding rerun time. This latter procedure will be followed if such work can be handled in approximately an hour. If not the engine will be taken off since otherwise it could disrupt test schedules.

Also, if an engine is delivered with a minor fault causing premature removal, but the customer is not sure as to the problem, it can be run on the stand, and with the shop foreman present, a diagnosis can be made which will shorten repair time when it enters shop.

PRODUCTION BRIEFING

Ford Aeronutronic Division has received a $5.4-million Army contract for continued development of the Shillelagh anti-tank missile. Aeronutronic previously received a $3.3-million development contract for the missile.

Martin Co. has a $15-million Navy contract to continue production of the Bullpup air-to-surface missile, bringing to $75 million the total Martin has received for the weapon. Maxson Electronics Corp., second production source for Bullpup guidance and control components, received a $1-million contract.

Westinghouse Electric Corp. has a $7.3-million Navy contract to develop and produce the weapon direction equipment for the Typhon weapon system. Westinghouse last year received a $38.5-million contract for the long-range radar portion of Typhon, which is designed to control shipboard Tartar, Terrier, Talos and Super Talos missiles.

General Electric Missile and Space Vehicle Department has a $28-million USAF incentive contract to develop Mark 6 nose cones for Titan II. Ultimate contract amount depends on delivery schedule, cost control, quality and flight performance.

Airborne instrumentation sites to support the Atlantic Missile Range will be developed by Temco Overhaul and Aerosystems Division of Ling-Temco Electronics, Inc., Greenville, Tex., through modification of Lockheed C-130A Hercules turboprop transports for Air Materiel Command. A $1.5-million letter contract has been awarded Temco with dollar value of the definitive contract expected to be approximately $3 million.

Pratt & Whitney Aircraft has a $9-million Navy contract for continued development of the TF-30 turbofan engine, planned for use in the Douglas F6D Missileer interceptor. Navy says the 10,000-lb. thrust engine will have potential use in light attack and small transport aircraft.

Western Electric Corp. has been awarded an $8.3-million contract by the Navy for additional production of the radar portion of the air missile control system on McDonnell F4H-1 Phantom.

Raytheon has a $28.2-million Navy contract for continued production of Sparrow III missiles. Work will be done at the company's Lowell, Mass., and Bristol, Tenn., plants.

Current Vertol Helicopter Airframes Contrasted

Fuselages of Boeing Airplane Co.'s Vertol Division HC-1B Chinook helicopter (right) and 107 Model II (left) are shown nearing final assembly in Vertol's Morton, Pa. plant. The HC-1B is being prepared for Army delivery under a $25,357,544 contract; the 107 recently won Marine Corps' helicopter competition (AW Mar. 6, p. 37, 52).

FINANCIAL

New Offerings

Adler Electronics, Inc., New Rochelle, N. Y., engaged in the design, development, production and sale of advanced electronic communications systems and equipment, including transportable communications systems and heterodyne repeater transmitting and receiving equipment for radio, television and microwaves. Offering is 160,000 shares of common stock for public sale; 110,000 shares to be offered by the company, and 50,000 outstanding shares by the present holders thereof. Offering is to be made on an all or none basis; offering price and underwriting terms to be supplied by amendment. Proceeds from the company's sale of additional stock will be added to working capital; initially the proceeds will be used to pay a $500,000 demand bank loan and the balance to reduce $1,584,647 of short-term bank loans which were incurred to defray expenses of production.

Beckman Instruments, Inc., Fullerton, Calif.; the company and its subsidiaries are engaged in designing, developing, manufacturing, and selling precision instruments for scientific, industry, medical, and laboratory use. Offering is 69,976 shares of common stock for subscription by stockholders on the basis of one new share for each 20 shares held; record date, subscription price and underwriting terms to be supplied by amendment. Of the proceeds, $3,500,000 will be used to repay short-term bank loans incurred since June, 1960, to help defray the cost of plant expansion and new equipment; balance will be added to general funds available for corporate purposes.

Photronics Corp., Flushing, N. Y., organized in March, 1959, to engage in the business of engineering and manufacturing photo-optical and electro-optical systems and components. Since October, 1959, it has designed, developed and manufactured equipment said to have been used in areas such as aerial reconnaissance, photo-interpretation, photogrammetry and optical scanning devices. Offering is 150,000 shares of common for subscription by stockholders at the rate of three new shares for each four shares held; record date, subscription price and underwriting terms to be supplied by amendment. Proceeds will be added to working capital; it is expected that $40,000 will be used for the company's research and development program, and $30,000 for laboratory instruments and glass working machinery, etc.

Acme Missiles & Construction Corp., Rockville Center, N. Y., has been engaged in the construction and installation of missile launching platforms, and it is said to have broadened its activities in this and the general construction field. Offering is 30,000 outstanding shares of Class A common stock for public sale by the present holders thereof; offering price to be supplied by amendment.

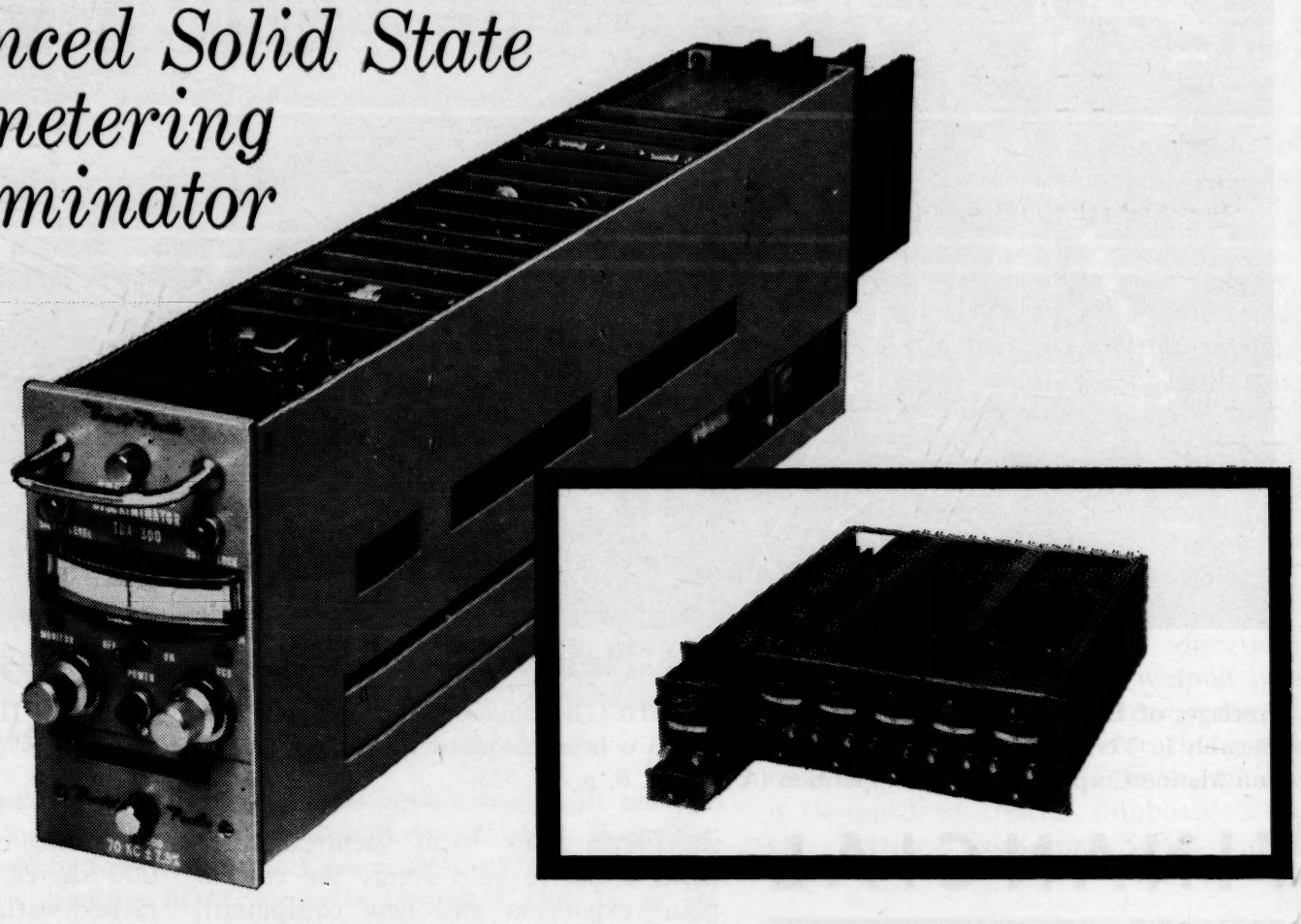
Boonton Electronics Corp., Morris Plains, N. J., engaged in the design and manufacture of precision electronic measuring equipment. Offering is 60,000 shares of common stock and attached warrants for public sale in units, each unit consisting of one common share plus ½ of a two-year warrant. One full warrant will be required to purchase one share at $5.50 per share during the first year and $6.50 per share the second year. Offering is to be made on an all or none basis, at $5.50 per unit. Of the proceeds, $10,000 will be used to move to new plant facilities, including leasehold improvements, moving expenses, and security deposits; $135,000 to expand production facilities, discount purchases, and to purchase inventory items in quantity; $45,000 for additional advertising and sales promotion; $80,000 to expand research and development.

The company has sold to underwriters a $55,000 principal amount 3% convertible note, due January, 1962, and warrants to purchase 5,000 common shares, for an aggregate of $55,000, which note will be converted on the effective date of this offering into 10,000 common shares. The company also has sold to a limited group, including the underwriters and associated persons, 17,500 common shares and warrants to purchase an additional 17,500 common shares for an aggregate of $19,250. Proceeds from the exercise of warrants will be used as additional working capital.

Progress Webster Electronics Corp., Chester, Pa.; the company and its subsidiaries are engaged in the business of manufacturing, distribution and developing electronic equipment and components and related products for residen-

NOW... from Bendix-Pacific

Advanced Solid State Telemetering Discriminator



In this TDA-300 Solid State Subcarrier Discriminator Bendix-Pacific has achieved a new standard of performance in an accurate and reliable data converter for use in FM/FM telemetry receiving stations and data reduction systems. Smaller in size for comparable performance, completely accessible plug-in printed circuit modules and built-in power supply are characteristic features of its advanced design. Because of its minimum size and weight the Discriminator is particularly suited for use in aircraft and for installation in crowded mobile vehicles.

The Discriminator uses the phase lock loop concept of coherent detection to obtain maximum recovery of FM subcarrier signals. A mounting rack is available which permits mounting six discriminators in 5¼ inches panel height in a standard 19 inch rack. Provided on the front panel of the Discriminator are a horizontal panel meter, out-of-lock and low signal level lights, panel switch and adjustments for zero balance and voltage output.

DYNAMIC INPUT RANGE	10 millivolts to 10 volts rms (60 db) without input adjustment
FREQUENCIES AND BANDWIDTHS	MIL-T-26985 (IRIG) center frequencies and bandwidths are standard. Other center frequencies to 300 KC and bandwidths can be supplied
LINEARITY	Static linearity is within ±0.05% bandwidth of best straight line. Distortion of alternating inputs with modulation indices greater than 5 (dynamic linearity) is less than 1.0% bandwidth
POWER REQUIREMENT	Integral power supply operates from 105 to 125 volts rms at 40 to 420 cycles per second. Power consumption is less than 40 watts
SIZE	5¼ x 2 13/16 x 20 inches

Complete data and specifications are available on request.

THE Bendix CORPORATION

Bendix-Pacific Division

NORTH HOLLYWOOD, CALIF.

tial, commercial and military use. Offering is 150,000 shares of common stock for public sale at $4.50 per share. Proceeds will be added to general working capital for use in carrying an increased investment in inventories; for research and development; the acquisition of additional machinery and equipment, and intensified sales and promotion.

Wyle Laboratories, El Segundo, Calif. In its Testing Division, the company operates a laboratory providing testing services to the missile-space-aircraft industry; in its Manufacturing Division, the company has developed and produces several proprietary product lines including modular walk-in environmental test chambers, the Hydrashaker (a high-force electro-hydraulic vibration system) and liquid carbon dioxide storage and handling equipment. Offering is 110,000 shares of common stock; 100,000 shares for public sale by the company and 10,000 outstanding shares by Frank S. Wyle, president. Public offering price and underwriting terms to be supplied by amendment. Of the proceeds, $950,000 will be used to repay that portion of short-term bank borrowings incurred to finance the early stages of the company's expansion program and to defray costs of completing them; balance will be added to working capital to be used principally for carrying an increased volume of trade accounts receivable, and a portion of such balance will be used to repay all other short-term bank borrowings.

Stock Transactions

The Securities and Exchange Commission's Summary of Security Transactions and Resultant Holdings for the period Nov. 11 to Dec. 10, 1960, reported the disposition of 40,000 common shares of National Airlines, Inc., stock by G. T. Baker, officer and director, leaving a holding of 168,932 (his indirect holdings, jointly owned, remain 1,041).

Other transactions for the period Nov. 11 to Dec. 10 include:

Avco Corp. Acquisition of 1,000 common shares through exercise of option by John Mihalic, Jr., officer, making a holding of 7,300.

Beech Aircraft Corp. Acquisition of 525 common shares through exercise of option by Leddy Greever, officer, making a holding of 7,548*; acquisition of 210 common shares through exercise of option by Lee O. Higdon, officer, making a holding of 1,575*; disposition of 100 common shares and acquisition of 400 common shares through exercise of option by James N. Lew, officer, making a holding of 4,200*. (* After 3-for-1 split.)

Braniff Airways, Inc. Acquisition of 200 common shares by Reginald Brack, officer, making a holding of 500.

Capital Airlines, Inc. Disposition of 1,700 common shares by James R. Stockton, director, leaving a holding of 2,610.

Cessna Aircraft Co. Disposition of 2,500 common shares by Robert L. Lair, officer, leaving a holding of 2,600.

Continental Air Lines, Inc. Acquisition of 5,365 common shares by Frederick L. Ehrman, director, making a holding of 9,500; acquisition of 715 common shares (315 shares through exercise of option) by Harding L. Lawrence, officer, making a holding of 925.

General Precision Equipment. Acquisition of 1,400 common shares by the Martin Co., beneficial owner, making a holding of 194,300; acquisition and disposition of 130 shares of $4.75 preferred, his total indirect holdings in partnership, by John C. Maxwell, director; disposition of 200 shares of $3 preferred by Donald W. Smith, officer and director, leaving a holding of 500.

Grumman Aircraft Engineering Corp. Acquisition of 300 common shares through exercise of option by William J. Hoffman, officer, making a holding of 388.

Ling-Temco Electronics. Acquisition of 3,800 common shares by D. H. Byrd, director, making a holding of 76,803; disposition of 1,600 common shares, his total holding, by Oswald G. Villard, Jr., director; acquisition of 400 common shares by Lee D. Webster, officer and director, making a holding of 1,000.

Lockheed Aircraft Corp. Acquisition of 979 capital shares through exercise of option by Herschel J. Brown, officer, making a holding of 1,458; acquisition of 1,224 capital shares through exercise of option by Donald H. Cameron, officer, making a holding of 2,925; acquisition of 1,224 capital shares through exercise of option by John E. Canaday, officer, making a holding of 2,550; acquisition of 1,224 capital shares through exercise of option by Frank L. Frain, officer, making a holding of 3,498 (indirect holdings remain 108); acquisition of 3,672 capital shares through exercise of option by Courtlandt S. Gross, officer and director, making a holding of 32,425; acquisition of 2,856 capital shares through exercise of option by Daniel J. Haughton, officer and director, making a holding of 9,324; acquisition of 1,305 capital shares through exercise of option by Clarence L. Johnson, officer, making a holding of 2,847.

Marquardt Corp. Disposition of 1,800 common shares by Clifford D. Cooper, officer, leaving a holding of 36,638.

McDonnell Aircraft Corp. Disposition of 1,400 common shares by C. Warren Drake, officer and director, leaving a holding of 12,750 (indirect holdings in joint tenancy remain 1,892); acquisition of 432 common shares as compensation by D. C. Fabiani, officer and director, making a holding of 682.

North American Aviation. Disposition of 2,100 capital shares by J. L. Atwood, officer and director, leaving a holding of 3,000; acquisition of 2,000 capital shares through exercise of option by Gerald B. Brophy, officer and director, making a holding of 3,734; acquisition of 300 capital shares through exercise of option by Rulon Nagely, officer, making a holding of 800; acquisition of 200 capital shares through exercise of option by Leland R. Taylor, officer, making a holding of 200.

Pan American World Airways. Disposition of 1,125 capital shares by Henry H. Berke, officer, leaving a holding of 2,000; disposition of 200 capital shares by John S. Woodbridge, officer, leaving a holding of 400.

Trans World Airlines, Inc. Acquisition of 850 Class A common shares by Samuel C. Dunlap, III, officer, making a holding of 2,850.

United Air Lines, Inc. Acquisition of 101 common shares by H. Templeton Brown, director, making a holding of 763; acquisition of 500 common shares through exercise of option by Rexford E. Bruno, officer, making a holding of 679 (indirect holding remains 39); disposition of 400 common shares by Eric Johnston, director, leaving a holding of 4,911; acquisition of $3,000 of 4¾% convertible subordinated debentures by Martin C. Ansorge, director, making a holding of $3,000; acquisition of $10,000 of 4¾% convertible subordinated debentures by Eric Johnston, director, making a holding of $10,000; acquisition of $1,000 of 4¾% convertible subordinated debentures by S. P. Martin, officer, making a holding of $1,000; acquisition of $10,000 of 4¾% convertible subordinated debentures by Vernon Stouffer, director, making a holding of $10,000.

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Offers a wealth of practical know-how for effective data recording and reproduction. Explains such techniques as FM carrier, pulse-duration modulation, and carrier-erase and digital-pulse recording. Includes discussions of tape machine imperfections, phase characteristics of a magnetic tape system, and the effects of flutter. **By G. L. Davies, Consult. Engr. 257 pp., 86 illus., $8.50.**

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A unified account of principles, design criteria, and applications of feedback and adaptive control systems. Presents practical information on automatic methods of process identification, adaptive systems developed at industrial research laboratories, and proposed computer-controlled adaptive systems. Treats both linear and nonlinear systems. **Edited by E. Mishkin and L. Braun, Jr., Poly. Inst. of Bklyn. 533 pp., 379 illus., $16.50.**

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AIR TRANSPORT FACTS AND FIGURES

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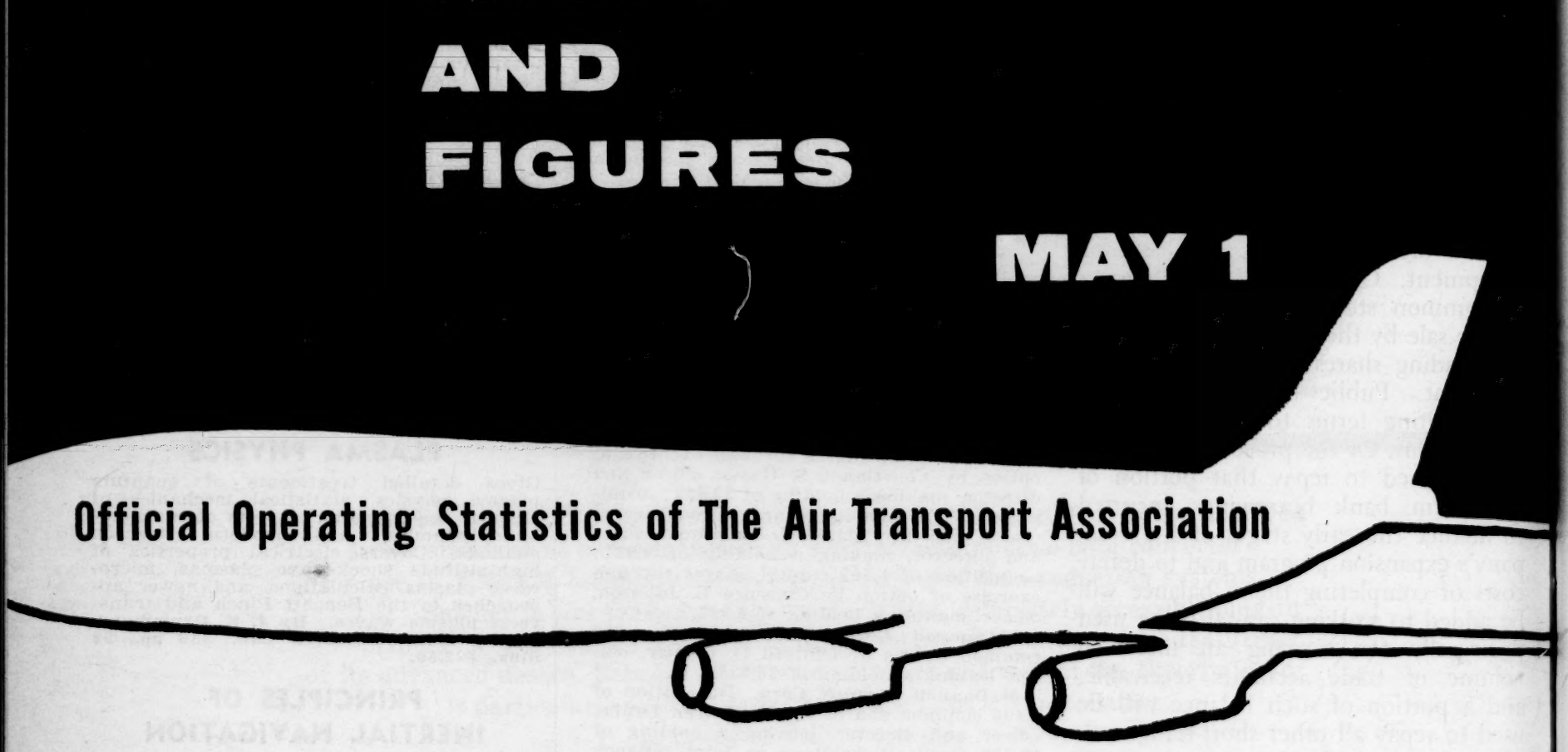

Official Operating Statistics of The Air Transport Association

For the past five years,
AVIATION WEEK and Space Technology has published
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will also cover, in depth, key subjects
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Aviation Week
and *Space Technology*

A McGraw-Hill Publication,
330 West 42nd Street, New York 36, New York

WHO'S WHERE

(*Continued from page 19*)

Honors and Elections

Robert E. Gross, board chairman and chief executive officer of Lockheed Aircraft Corp., has been awarded an honorary Doctor of Laws degree by the University of California.

Paul F. Bikle, director of NASA's advance flight base at Edwards AFB, and the late **J. Shelly Charles,** a retired Eastern Air Lines captain, have been elected to the Helms Hall Soaring Hall of Fame.

Sam E. Keith, chief of traffic for Convair Division of General Dynamics Corp., has been elected chairman of the Western Traffic Committee for the Aerospace Industries Assn., and **M. H. Savard,** head of traffic for Hughes Aircraft, was elected vice chairman. Also: **R. Earl Miller,** traffic manager of the Bendix Corp.'s Kansas City Division, elected chairman of the Rate and Classification Subcommittee.

Changes

Thomas E. Daniels, military systems sales manager for the Dallas, Tex., Division of Collins Radio Co.

Dr. Taffee T. Tanimoto, head of the Pattern Recognition Laboratory, Melpar's Applied Science Division, Watertown, Mass.

Harold W. Austrow, chief engineer, Aircraft Equipment Division, Consolidated Diesel Electric Corp., Stamford, Conn.

Robert Provart, director, Astromatic Division, Controls Company of America, Schiller Park, Ill.

Lt. Col. Frederick M. Armstrong, Jr. (USAF, ret.), manager of field engineering, Southeastern Area Office (Cocoa Beach, Fla.), Defense Systems Department of Servo Corp. of America.

Dr. Yujiro Yamamoto, head of recorder engineering, Borg-Warner Controls Division of Borg-Warner Corp., Santa Ana, Calif.

John L. Roberts, manager, Space Technology Div., Quantatron, Inc., Santa Monica.

Fred C. Mehner, administrative general manager, Horkey-Moore Associates Division of Houston Fearless Corp., Los Angeles.

Leon F. Edelson, director of engineering, Ultrasonic Systems, Inc., Los Angeles.

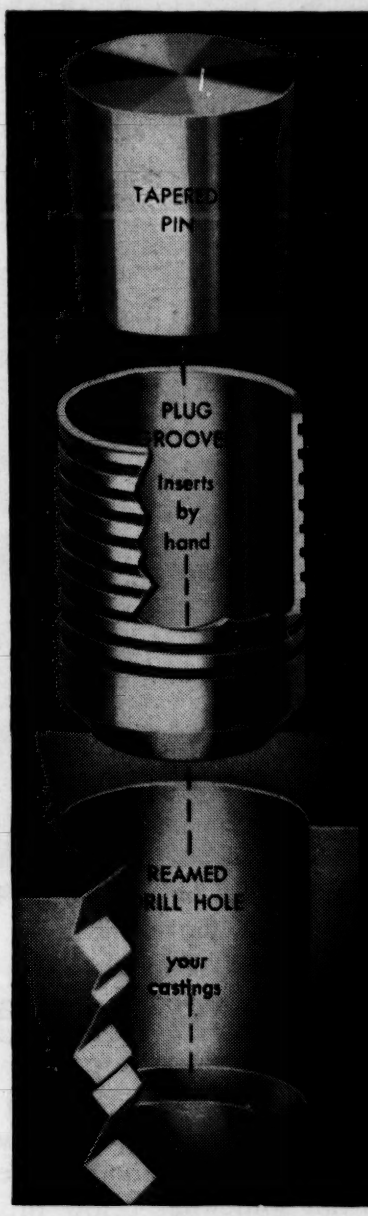
Ralph G. Mork, manager-Engineering Laboratory, IBM Federal Systems Division's Command Control Center, Kingston, N. Y., succeeding **Henry E. Cooley,** now manager-data communication development on the staff of IBM vice president and group executive, White Plains, N. Y.

Kenneth J. Slee has joined the corporate public relations and advertising staff of Litton Industries, Beverly Hills, Calif., to direct the advertising activities and provide marketing assistance to Litton Systems.

Robert L. Crouse, manager-value engineering, Aeronautical Division of Minneapolic-Honeywell Regulator Co., Minneapolis.

Capt. Will I. Bull (USN, ret.), director of operations, and **Dr. Paul N. Russell,** technical director, Semiconductor Division of Hoffman Electronics Corp., Los Angeles.

Morton P. Duffy, manager-programs management office, Data Systems Operations, Sylvania Electric Products, Inc., Needham, Mass.



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PROBLEMATICAL RECREATIONS 59

A's age equals B's age plus the cube root of C's age. B's age equals C's age plus the cube root of A's age, plus 14 years. C's age equals the cube root of A's age plus the square root of B's age. What is the age of each? —*American Mathematical Monthly*

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ANSWER TO LAST WEEK'S PROBLEM: Let AT and BT be the tangents, ACB the arc, O the center, OA the radius. Let angle AOT = x and AO = r. Then arc ACB = $(2\pi - 2x)\ r = 1$, and $\tan x = 1/r$; whence $\tan x = 2\ (\pi - x)$. By approximation: $x = 74°\ 46.2'$. $r = 1$ mile/$\tan x$ = 5280 feet/$\tan x$ = 1437.45 feet.

LITTON INDUSTRIES
Beverly Hills, California

AEROCAR roadable airplane is a four-wheel pusher type vehicle powered by a modified 143-hp. Lycoming air-cooled engine. It can cruise at 100 mph. and has an aerial range of 300 mi., requiring about 650 ft. for takeoff.

Auto Sales Techniques Used for Aerocar

By Erwin J. Bulban

Dallas, Tex.—Merchandising and distribution techniques similar to those used for selling autos are programed for the Aerocar roadable airplane. "Downtown" display and exposure will be utilized for the Aerocar when it becomes available to the public late this year, pending success of current production plans.

Contract has been signed by Aerocar International Corp., Ft. Worth, Tex., with Temco Missiles & Aircraft Division of Ling-Temco Electronics, Inc., Dallas, for quantity production of M.B. (Molt) Taylor's two-place Aerocar, contingent upon sufficient orders being realized by July 1 to warrant tooling costs. The roadable airplane would be produced at Temco's Grand Prairie plant here.

Officials Confident

Aerocar International officials appear confident that they will meet the production requirements by the target date and have been busy developing plans for a distributor-dealer sales and service network and are currently interviewing distributor applicants. They have indicated that they will be talking very soon to one interested prospect from the Midwest who is interested in placing an order for 150 Aerocars.

Minimum production requirements are not being publicly discussed by either Temco or Aerocar International, but indications are that 500 comes close to what Temco considers necessary to make the venture successful. Possibility, however, is that it may initiate production plans should the actual orders fall somewhat below this figure at the July 1 target date provided that the situation looks likely that any deficit will be made up shortly afterward. Aerocar International officials estimate that they will have close to 2,500 bona fide orders for the roadable aircraft prior to roll-out of the first production vehicle.

Roy Hyde, Aerocar International president, estimates that sufficient orders will be on hand within 60-90 days to justify starting to tool-up for production. This would mean that initial production models will be in the hands of distributors late this year, he says. Deposits on orders will be held in escrow by Temco.

Aerocar International's marketing plans call for setting up 21 franchised distributors in the United States which in turn would have 772 dealer outlets. Plans are to establish distributors as wholesalers only, non-competitive with their dealers. According to Hyde, the company already has signed options with at least three distributors covering firm territories.

Company is talking to aircraft as well as automobile sales operators and it emphasizes that it expects prospects to be capable of running their own show without the company's financial assistance.

Program Standards

Program will insist on certain minimum standards being met in the operation. In this regard, Aerocar International already has made arrangements with Inland Steel to design facilities for dealer operation. These turnkey facilities apparently closely follow Beech Aircraft Corp.'s program of uniform design and identification to establish the company image (AW Dec. 12, 1960, p. 132). To be available on a five-year financing program arranged between dealer and the steel firm, these facilities will be available in three major categories:

- **"A" dealer** will have available a plant

Four-Place Aerocar

Dallas, Tex.—Four-place version of the Aerocar is the next logical step in the roadable aircraft's development future, according to Molt Taylor, vice president-engineering of Aerocar International. Taylor does not envisage production on this model, however, until the current, two-place vehicle is well under way.

Cost of such a vehicle would be about $25,000-$30,000. It will probably utilize a new powerplant system on which Taylor has done preliminary design studies based on multi-engine concepts. He indicated that the powerplant probably would be produced by a current auto maker, although it is possible that an aircraft engine producer would also handle it.

Performance of the four-place Aerocar development would include cruise speed in the area of 135-150 mph.

measuring 70-ft. wide x 100-ft. long, which could be erected for approximately $30,000 upon his land, depending upon his location in the U. S.

• **"B" dealer** would have a 70-ft. wide x 80-ft. long plant, costing $25,000 to erect.

• **"C" dealer** would have available a 40-ft. x 80-ft. facility costing $10,000.

Aerocar International states that it plans to remain as strictly a parent firm arranging production, delivery and distributor-dealer sales and service assistance—it does not intend to take on a territory and handle any of the distributor-dealer functions. Franchises being signed with distributors are based on a 10-yr. term.

Prospective Distributors

Although no names of prospective distributors are being discussed, indications are that Robert Cummings, television and screen personality, who has had an interest in the Aerocar program for some time, will probably assume a territory.

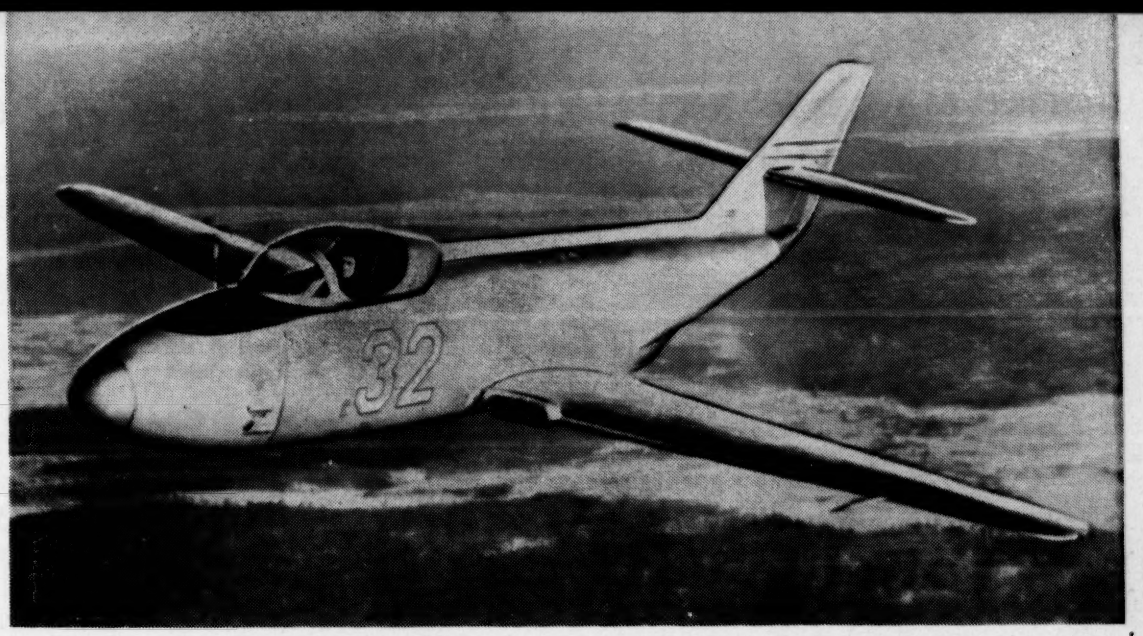
Production of the Aerocar at Temco will utilize conventional techniques and tooling—no radical approaches are being considered. The basic Aerocar two-place design will be followed, except that some 240 detail changes are anticipated in designing detail shop drawings to permit economical production and provide clean-up in appearance. The leading edge of the wing skin, for example, will be flush riveted compared with current protruding rivet heads on the certificated demonstration model. Moldings around doors and windows will be revised for easier fabrication and assembly, as will current construction of doors and certain fuselage panels. Wing struts will be provided with boot-type fairings and aileron actuators will also be faired in to clean-up the appearance for public consumption.

Changes will not require any recertification of the basic current flying aircraft, according to designer-builder Molt Taylor.

Preparing the roadable airplane for production, including preparing detailed shop drawings and tooling, will cost an estimated $1 million-plus, according to a source close to the project, and charges are to be borne by Aerocar International Corp. Production version will list at $13,990 retail.

New Firm

Aerocar International Corp. is a new firm formed recently by Roy Hyde of Ft. Worth, with Molt Taylor as vice president-engineering and Herman Zimmer, vice president-marketing. Hyde is president of Hyde Investment Co., Ft. Worth, a two-year-old factoring firm, which has been negotiating with Taylor since last October on forming the new company to establish Aerocar production and marketing programs. Zimmer's experience includes that of factory sales manager and regional sales manager with distributor management responsibilities for several major U. S. consumer-item manufacturers. Hyde and Taylor consummated their arrangements in setting up Aerocar International two months ago. Both Hyde and Zimmer are pilots and use a Beech Bonanza company plane in



Soviets Claim Altitude Record

New Russian, single-engine, jet sports plane—the Yak-32—recently set a national altitude record of 14,283 meters (46,860 ft.) for craft in its weight category. The mark is being submitted to FAI for certification as a world record. Soviet reports give few details on the low-wing Yak-32, stating only that it is the USSR's first turbojet-powered acrobatic, sports and training plane. It has a pressurized cockpit, is equipped for all-weather flying, and reportedly has a short takeoff and landing run. Although the plane carries the "Yak" designation, its design is attributed to the collective headed by both A. S. Yakovlev and S. K. Tumansky. Both have the title of "general aviation industry designer." Test pilot Valentin G. Mukhin was at the controls during the Yak-32's record-breaking flight.

U.S. Business & Utility Aircraft Shipments

December, 1960

Make and Model	No. of Units	Net Billings
Beech Model 18	5	
Model 33 Debonair	26	
Model 35 Bonanza	39	
Model 50 Twin-Bonanza	8	$4,218,000
Model 55 Baron	12	
Model 65 Queen Air	7	
Model 95 Travel Air	3	
Callair A-5	1	$9,000
Cessna Model 150	27	
Model 172, Skyhawk	82	
Model 175, Skylark	68	
Model 180	31	$6,556,000
Model 182, Skylane	123	
Model 210	89	
Model 310	21	
Champion 7EC Traveler	5	
7FC Tri Traveler	5	
7GCA, B Challenger	9	$118,000
7HC DX'er	1	
Commander Model 500A, B, E	7	
Model 680E, F	9	$1,357,000
Model 720	1	
Mooney Mark 20	14	$253,000
Piper PA-18 Super Cub	16	
PA-22 Tri-Pacer	15	
Colt	16	
PA-23 Apache	22	$2,269,000
PA-23 Aztec	9	
PA-24 Comanche 180	12	
PA-24 Comanche 250	42	
PA-25 Pawnee	16	
Totals	741	$14,780,000

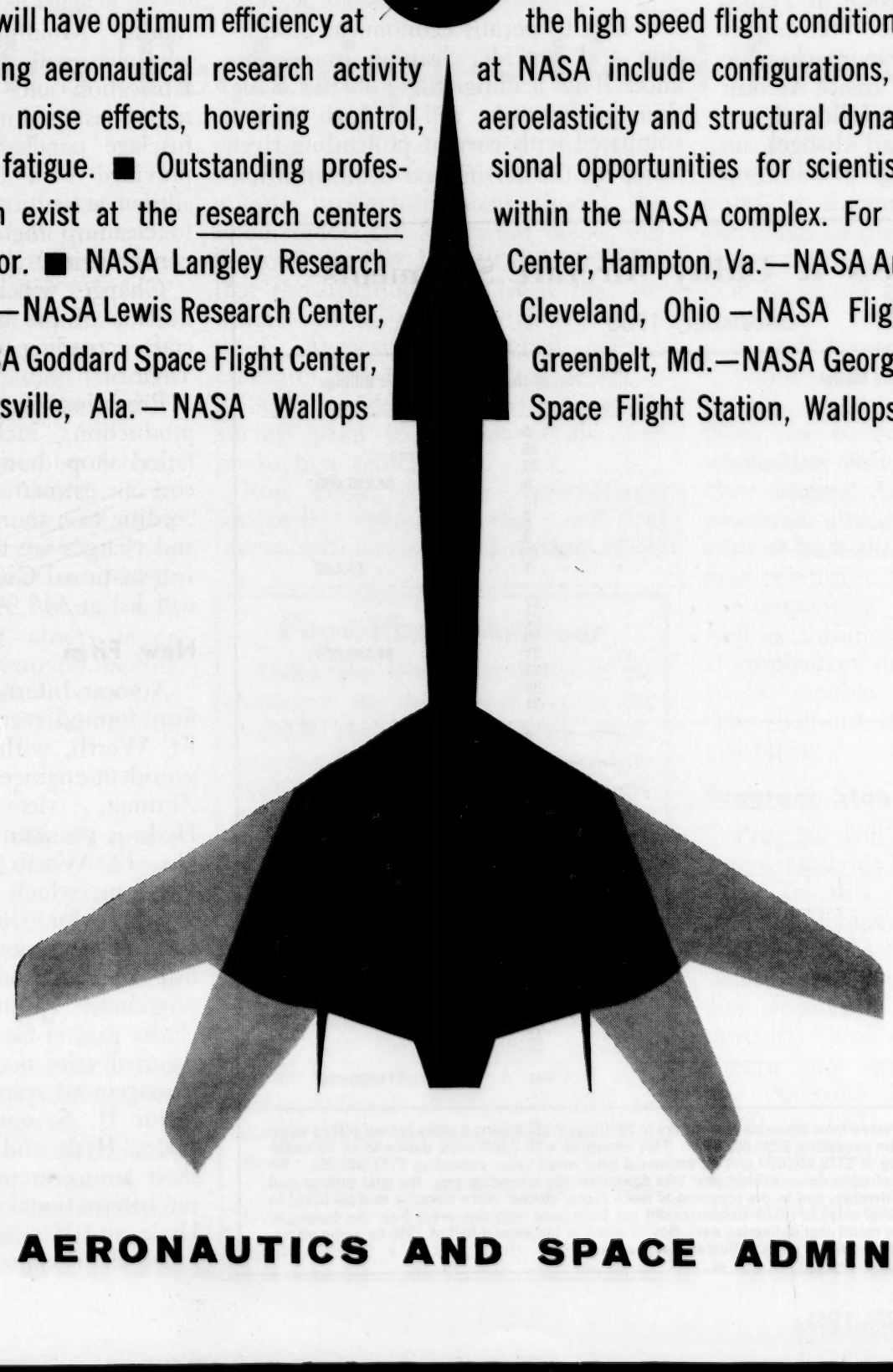
Note: Total number of aircraft delivered from these manufacturers in 1960 was 7,588 having a gross factory billing value of $151,220,000 and a retail value exceeding $200,000,000. This compares with 7,689 units delivered in Calendar 1959 having a total factory billing of $129,936,000 and an estimated total retail value exceeding $173,000,000. So despite the fact that the number of units delivered last year was down over the preceding year, the total billings and retail sales values were up considerably, due to the presence of more higher-priced, more complex models being in the 1960 line. Indications are that sales to retail customers did not keep pace with deliveries from the factory to distributors and dealers, with the result that deliveries were slowed down in the second half of 1960 by some manufacturers, probably accounting for the drop in units delivered last year over 1959.

FROM **NASA's** EXPANDING EFFORTS IN AERONAUTICAL RESEARCH

VARIABLE WING GEOMETRY

FOR TOMORROW'S AIRCRAFT FLYING AT MACH 2 TO MACH 6

Aircraft configurations most suitable for supersonic speeds have seriously reduced performance in takeoff, climb, and other off-design regimes. NASA scientists and engineers are engaged in an intensive research program on these problems. Variable wing geometry is one means of minimizing or overcoming these deficiencies without compromising supersonic cruise efficiency. ■ Variable wing geometry creates three aircraft in one. Such craft will exhibit high aerodynamic efficiency in climb and let-down and enjoy relatively low takeoff and landing speeds. Variable wing geometry will also allow aircraft to delay entering supersonic flight until reaching an altitude at which sonic boom effects are minimized. Then, with wings swept back, the craft will have optimum efficiency at the high speed flight condition. ■ Specific areas of intense and increasing aeronautical research activity at NASA include configurations, performance, flight characteristics, flight noise effects, hovering control, aeroelasticity and structural dynamics, high temperature materials, and fatigue. ■ Outstanding professional opportunities for scientists and engineers in aeronautical research exist at the research centers within the NASA complex. For full details, write to the Personnel Director. ■ NASA Langley Research Center, Hampton, Va.—NASA Ames Research Center, Mountain View, Calif.—NASA Lewis Research Center, Cleveland, Ohio —NASA Flight Research Center, Edwards, Calif.—NASA Goddard Space Flight Center, Greenbelt, Md.—NASA George C. Marshall Space Flight Center, Huntsville, Ala.—NASA Wallops Space Flight Station, Wallops Island, Va. ■ ■ ■



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

the course of Hyde Investment Co. interests.

Molt Taylor, who first flew his Aerocar in 1950 and has logged more than 1,000 flight hours and 100,000 road miles on the vehicle, was a naval aviator and project engineer at the Naval Aircraft Factory, Philadelphia, Pa., where he was officer in charge of pilotless aircraft and guided missile development, prior to setting up Aerocar, Inc., Longview, Wash.

Pusher-Type Vehicle

The two-place Aerocar is a four-wheel, pusher-type vehicle powered by a considerably modified 143-hp. Lycoming air-cooled engine. As an aircraft it cruises at 100 mph. and has a 300-mi. range, requiring some 650 ft. for takeoff.

Conversion from aircraft to automobile, or vice versa, can be accomplished rapidly using a single hand crank. Wings and tail are folded on the aft fuselage and can be towed behind the car portion. The car has a practical road speed of approximately 60 mph. and has standard fluid drive transmission with three forward speeds and one reverse.

A detailed pilot report on the Aerocar's flight handling characteristics has been covered in Aviation Week (AW Nov. 29, 1959, p. 116).

Narco Develops New DME, Radio Gear

National Aeronautical Corp. (Narco) has developed three new business airplane equipments, shown for the first time at its annual regional wholesaler meeting at King of Prussia, Pa.

New units are:

- **Narco UDI-2** distance-measuring equipment, follow-on to Narco's lightweight DME developed under Federal Aviation Agency contract. Unit sells for $2,250 and weighs 14 lb., half the price and weight of the UDI-1.
- **Mark 7 360-channel** VHF transceiver with 50-kc. spacing and a frequency range from 118 to 135.9 mc. Price of the transceiver is $1,195 and weight is 10.5 lb.
- **Mark 10 panel unit,** a 360-channel transceiver similar to Mark 7, and a 190-channel, crystal-controlled VHF receiver in the 108- to 126.9-mc. range. Mark 10 weighs 12.5 lb. and costs $1,695.

Narco sales awards went to: Air Associates, Chicago, Ill., largest total sales volume; Air Associates, Teterboro, N. J., best sales improvement, up 72%; Aviation Supply Co., Tampa, Fla., Million Dollar Round Table for sales of more than $1 million, and outstanding salesman, Pat Murphy, of General Aircraft Supply, Detroit, Mich. Other Million Dollar awards went to General Aircraft Supply, Air Associates, Chicago, and Van Dusen Aircraft Supplies, Teterboro, for topping $4 million in Narco sales.

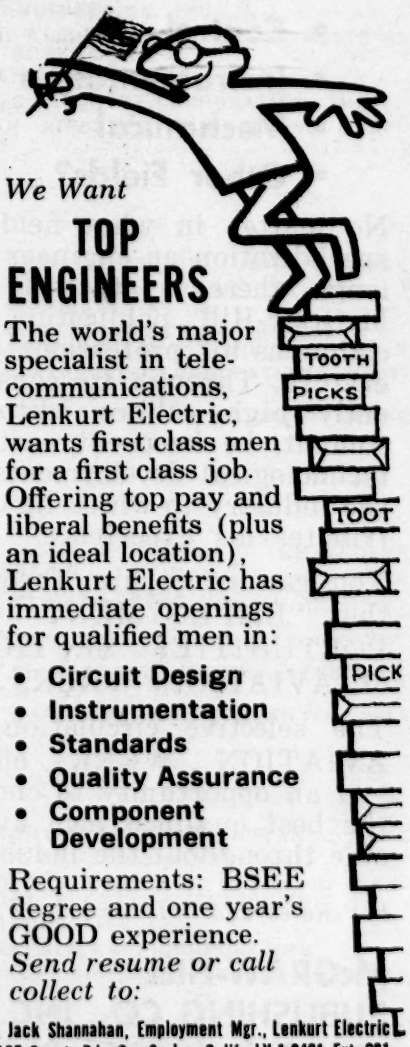
Airlift Plan Formed For Business Aircraft

Washington—An emergency airlift plan for business and private aircraft over 12,500 lb. has received "unqualified support" from several hundred aircraft operators, according to Commerce Department's Defense Air Transportation Administration.

The National Emergency Defense Airlift plan would use these business and private aircraft to airlift medical teams and supplies during the initial phase of a national emergency. The aircraft would be returned to owners later.

At present, there are about 1,200 aircraft owned by some 700 companies and individuals eligible for NEDA use.

The bulk of the NEDA-type fleet is in the Lockheed Lodestar—DC-3 category, but Viscounts, F-27s, Grumman Gulfstreams, and Lockheed Jet-Stars are currently beginning to come into service.



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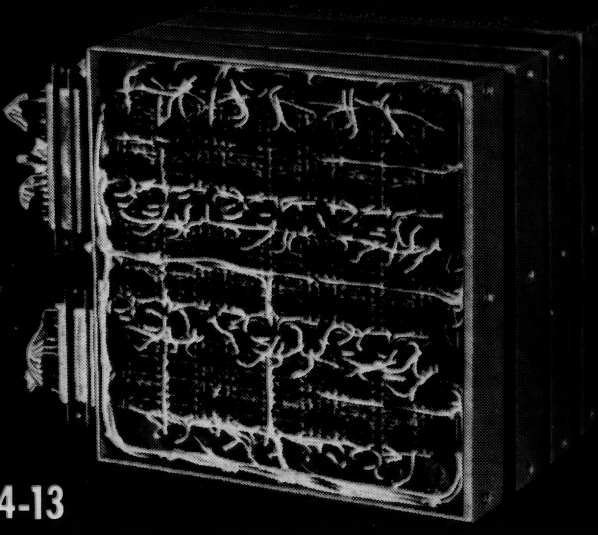

RIDL Model 34-13

The RIDL Model 34-13 is a special purpose Pulse Height Analyzer with time base Multiplexing storage and transmission ability. It may be used to measure and store low level signals from transducers linked with any type of sensing element or from any type of radiation equipment.

as analyzer

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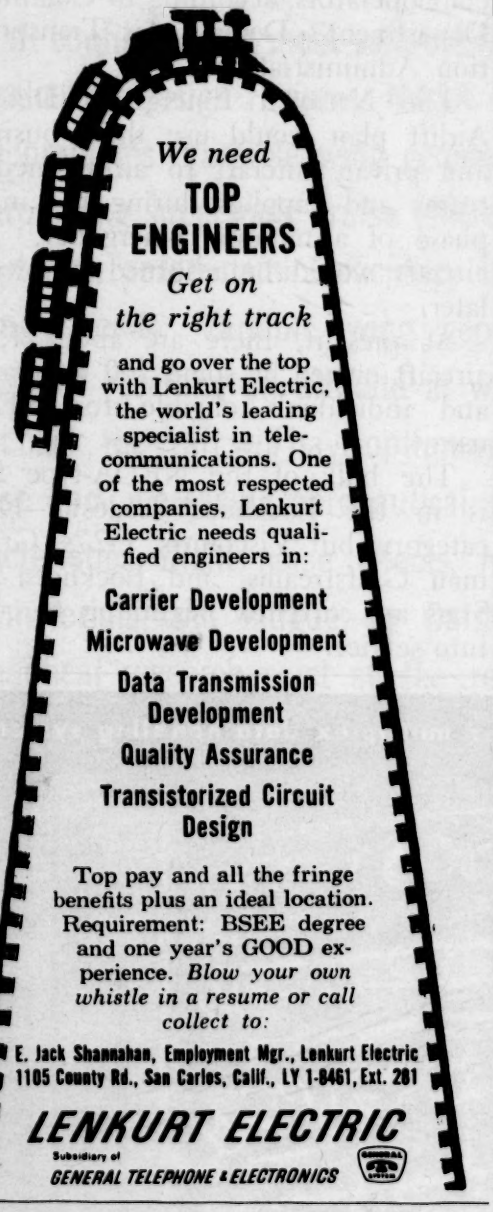

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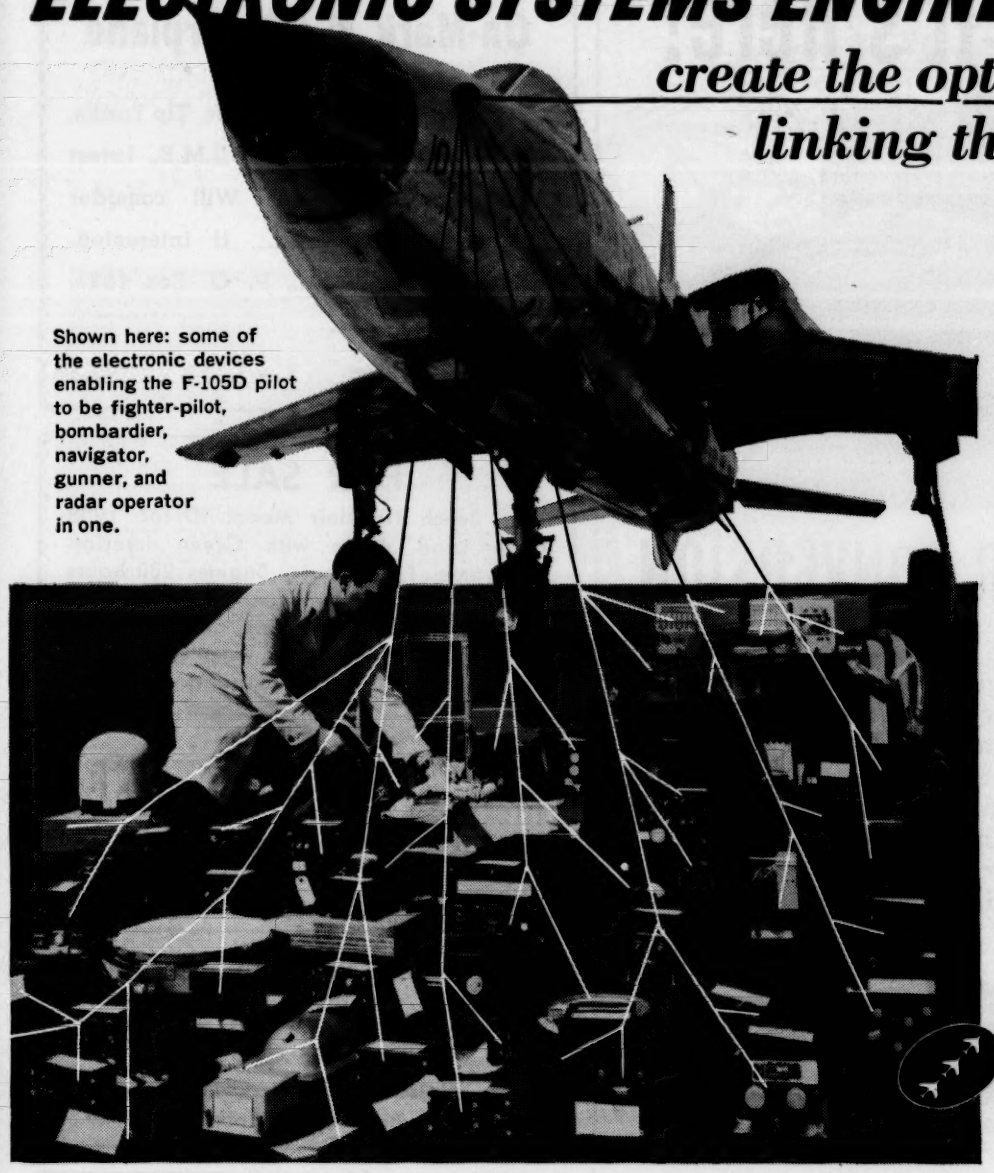

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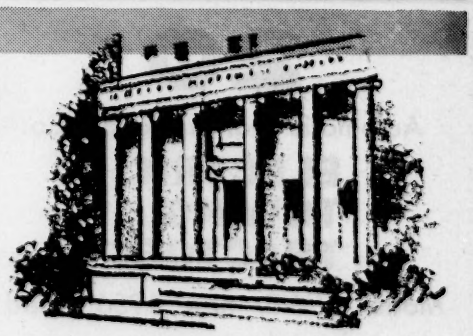

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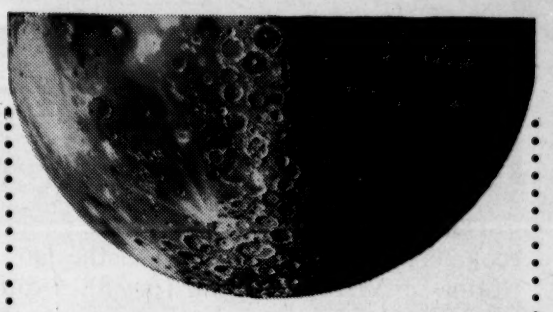

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Communists Overrated

I have just finished reading Gen. Irvine's economic study that appeared in the Jan. 2 edition of AVIATION WEEK (p. 78). I can't help but take exception to some of the assumptions set forth in this study.

The study begins with this sentence: "At the present time it is obvious that the Sino-Soviet bloc is matching us in over-all military capability." Obvious to whom? This is a large statement and a good case can be made to show that just the opposite is true.

With the exception of their excellent rocket boosters and large standing armies it can be argued that the Chinese and the Russians are actually behind the U. S. in over-all military capability. This is illustrated by their performance in the Korean War where they had some very real advantages.

Their inability to take South Korea shows that they need much more development and experience in the logistics required by modern warfare. Further, their great population and their tremendous land mass are not all asset to them either, as the industrial base required to support military operations today requires a skilled and educated population, efficient plants to produce and support modern weapons, and rapid transportation and communications facilities.

The very vastness and geography itself has so far inhibited the creation of really efficient transportation and communications required by today's warfare. The Eurasian fiasco in agriculture illustrates this point since one of the biggest problems in their agriculture is transportation.

When all elements are considered, the Sino-Soviet bloc, as China and Russia are called by our jet age semantics, have a long way to go before they can match the ability of the U. S. to project military force on a global basis. Missiles and ground forces are impressive but these are not the only elements to consider when assessing a nation's power.

This study attempts to make a case for a "national plan" for the next 50 years encompassing "military readiness," "economic warfare," and "spiritual combat." I can conceive of no facet of our lives that would not fall under these elements, save perhaps sex.

Is it so vital that we have a national plan just because our competitors have one? If the Russians establish a base in "Hell," is it vital that we have a base there, too? Perhaps more to the point, if we have to have one there, which branch of the service will control and man it?

This statement also appears in this study: "I think most economists agree that we could spend up to 15% of gross national product for the defense sectors of our economy without harmful effect." Our present GNP is about $500 billion, and 15% of this would represent $75 billion for the defense sector of our economy. The government will be lucky if it can raise $80 billion in revenues this year, and for us to spend $75 billion for defense and still maintain our civilian sector spending by the government at present levels would represent an inexcusable assault on the taxpayers of this country.

I believe that there are many economists and sociologists who think that our present tax levels are eroding the moral fibre of our society and to increase our present tax levels holds grave peril for our citizens.

The thought that this study leaves me with is that our government can stimulate growth through the creation of a national plan.

There is no sense in even planning unless one has the power to enforce the plan, and I, for one, think our government has too much power already. To conclude, this study with all its figures and charts does not support the case for a "national plan," and I am not at all sure that it doesn't do violence to the subject of economics.

JOHN R. TYLER, AKC USN
USS Hancock CVA-19 (CPO Mess)
c/o FPO San Francisco, Calif.

Production Pyramid

We all much appreciate the excellent job we have come to expect from Bill Reed on our 727 program (AW Mar. 6, pp. 60-65). The last paragraph seems to be badly infested with type lice, however. Although we have long claimed having the finest airplane manufacturing team in the world, and we don't doubt but that they could turn out 80 or 90 per month, salesmen here report some problems in selling sufficient airplanes to justify this rate of production.

GORDON WILLIAMS
Boeing Airplane Co.
Renton, Wash.

(Not type lice but too blunt an editor's pencil tracing graph curves caused this error. Boeing's Renton plant production rate should be 80 to 90 multi-jet aircraft per year, not per month.—Ed.)

Urban Bypass

As an avid and appreciative reader of your fine publication, and despite my standing as a rank amateur in the field of aviation, I should like to add some thoughts to the currently growing controversy regarding air traffic control. It seems to me that more than advanced technological improvements, such as data processing computers and improved type radars, are needed as a solution. I think careful scrutiny will reveal a basic flaw in our system of airways.

The airway system today is still based on the 30-year-old definition that "airways lead from city to city and airport to airport." This tenet is not only invalid, but contributes to the over-all problem. Suppose, instead, that airways were to lead in general north-south, east-west, and diagonal directions, bypassing all centers of population. Terminal airways would branch off from these through airways toward major airports, with facilities along the way for holding stacks, and oriented in such a way as to lead directly into low-altitude approach systems.

Through traffic would then be unhindered, and arriving and departing flights could make their climb-outs and let-downs without having to be interwoven into a pattern of through traffic.

Two other improvements might further alleviate the situation. The first is placing VOR (TAC) stations on movable truck vans, thus adding flexibility and adaptability to the system. The second consists of creating airways of dual or greater multiplicity. Today's airways, with their alternate segments (i.e. V55 W. V6S) do not represent a true net increase, since every 100 mi. or thereabouts here comes the traffic from, say, the center airway and its north and south alternates, all barreling toward a common VOR.

Leaving specifics for concepts, could it be that the national pattern of traffic, in all its forms, needs careful and critical scrutiny through the use of Operation Research?

My compliments on your fine magazine, which is read with great interest by many of our members who are trying to further the promotion of aerospace through the contribution of their voluntary efforts.

CLAUDE G. LUISADA
Director of Senior Education
Illinois Wing
Civil Air Patrol

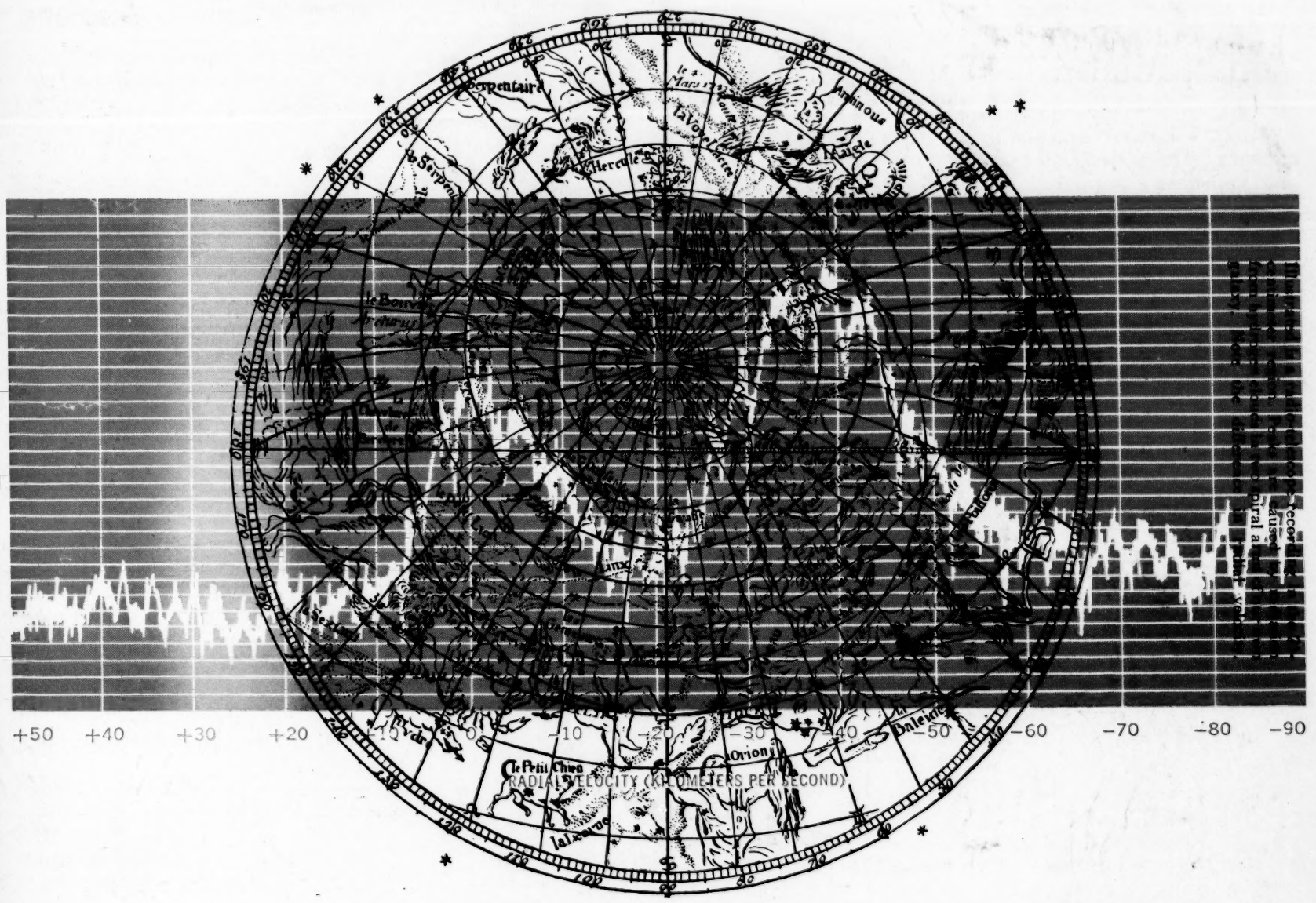
Work on Geriatrics

I read with interest the letter from Fred Volz that appeared in the Feb. 6 issue of AVIATION WEEK (p. 126). Work in this area (prolongation of life) has been under way for some time in several laboratories; some of the broadest-based and most intriguing is being carried out at the Bjorksten Research Foundation, a nonprofit foundation devoted exclusively to fundamental research on aging.

The research group there has accumulated considerable data to support the theory that aging is caused by crosslinking of the body's proteins, resulting in a "frozen" rather than a dynamic metabolic pool. (See Journal of the American Geriatrics Society, Vol. VIII, No. 8, Aug. 1960.) They are currently searching for agents that could reverse this cross-linking and "thaw" the frozen reserves; there appear to be analogous agents involved in certain natural processes.

This work is neither as widely known nor as deservedly supported as it should be. Certainly here is an area where a "crash program" could conceivably pay dividends beyond our imagination!

JACK H. STOCKER, PH. D.
New Orleans, La.



Harnessing The Red Shift

Most of our knowledge of the universe has been gained optically. Now, through the use of maser amplifiers applied to radio astronomy, measurements on the Doppler shift of emission lines and the absorption intensity of interstellar hydrogen are expected to add much to the knowledge of our own, as well as distant, galaxies.

Important aids to good "radio seeing" are LFE's ultra-stable oscillators used as power- and frequency-stable pumps for masers and parametric amplifiers. Even before this application, LFE had years of experience in making very good tunable microwave oscillators. Proven, rugged, reliable design, direct frequency calibration, simple controls and, above all, stability — both amplitude and frequency — all contribute to make our microwave oscillators ideal wherever stability and reliability count.

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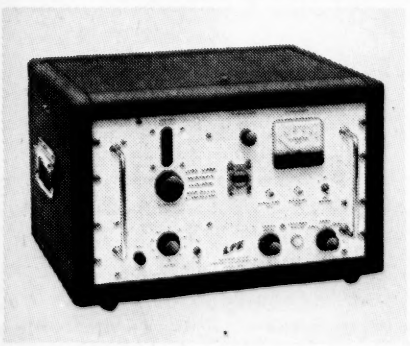

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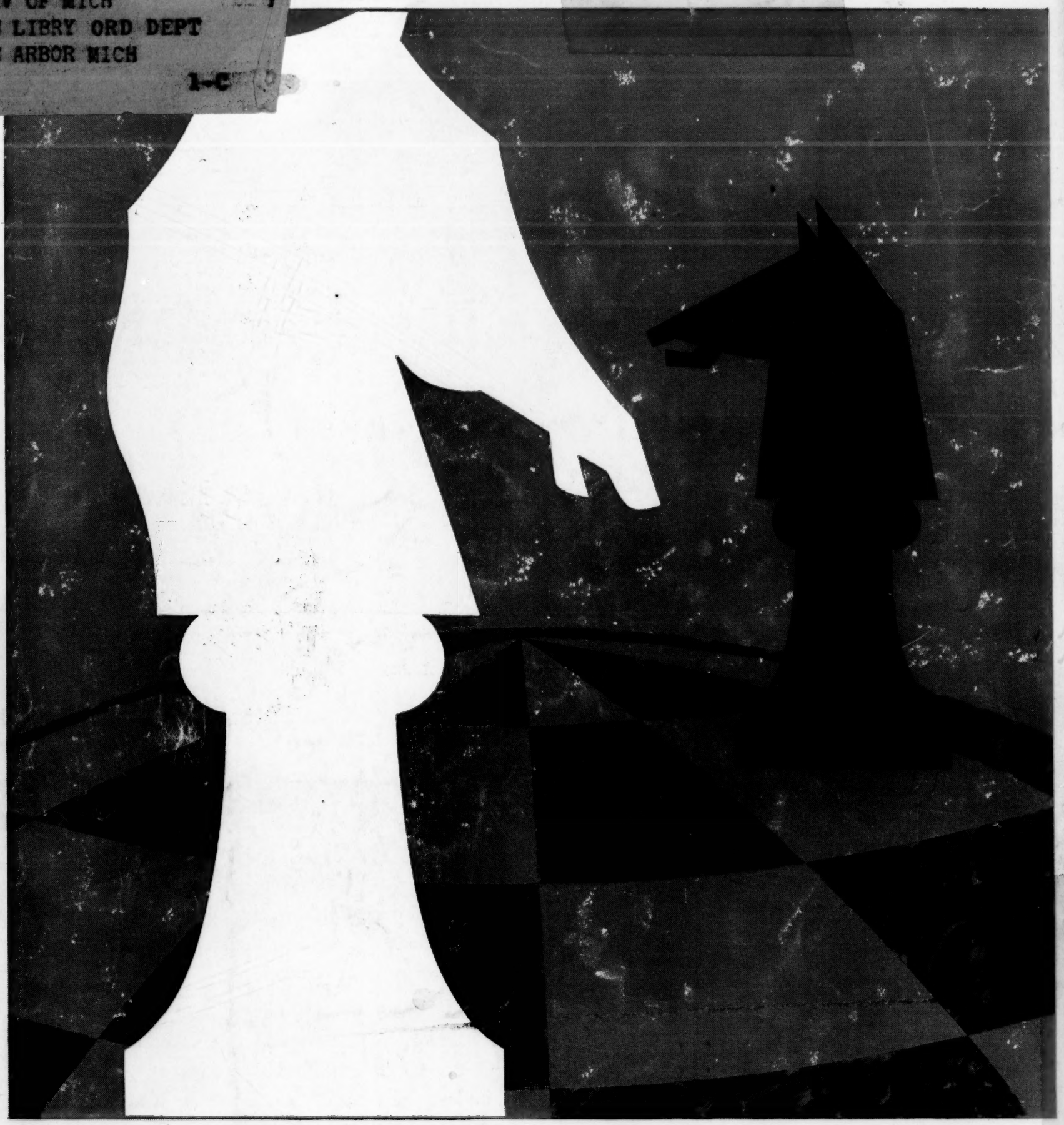

WHITE'S DEFENSE AT 76° N, 68° W...

Master chess demands the application of the science known as Game Theory. In modern military strategy, Game Theory is further refined to determine optimum moves in the mightiest contest ever known—the global match between the Free World and the Communist World.

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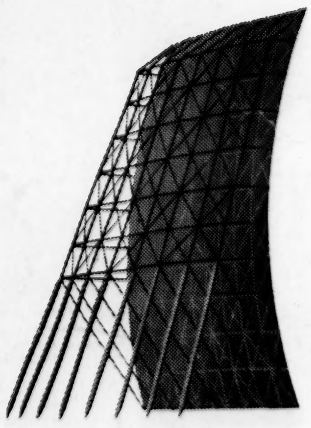

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